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FUEL AND OIL HOSES—SAE J30 JUN1998 SAE Standard

Report of the SAE Nonmetallic Materials Committee approved January 1946. Revised by the SAE Fuel, Oil, and Emission Hose Committee October 1987, completely revised June 1991, revised May 1993, December 1993, and June 1998. Rationale statement available.

This SAE Standard was formulated by SAE-ASTM Technical Committee on Automotive Rubber.

1. Scope—This SAE Standard covers fuel and oil hose, coupled and uncoupled, for use with gasoline, oil, diesel fuel, lubrication oil, or the vapor present in either the fuel system or in the crankcase of internal combustion engines in mobile, stationary, and marine applications. Sections 7 and 11 cover hose intended to meet the demands of fuel injection systems. Sections 10 and 11 cover hose intended to meet low fuel permeation requirements.

Section 3 covers Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R2).

Section 4 covers Lightweight Braided Reinforced Lacquer, Cement, or Rubber Covered Hose (SAE 30R3).

Section 5 covers Wire Inserted Synthetic Rubber Tube and Cover (SAE 30R5).

Section 6 covers Low-Pressure Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R6), (SAE 30R7), (SAE 30R8).

Section 7 covers Fuel Injection Hose Medium-Pressure Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R9).

Section 8 covers In-Tank, Low-Pressure, Uncoupled Fuel Hoses (SAE 30R10).

Section 9 covers Unified Method for Fuel Hose Permeation.

Section 10 covers Low Permeation Fuel Fill and Vent Hose (SAE 30R11).

Section 11 covers Low Permeation Fuel Feed and Return Hose (SAE 30R12).

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE and ASTM Publications shall apply.

2.1.1 SAE Publications—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1645—Information Report Covering Electrostatic Charge in Fuel Systems

SAE J1681—Gasoline/Methanol Mixtures for Material Testing

SAE J1737—Recommended Practice for Measurement of Permeation Resistance by the Recirculation Technique

SAE J1960—Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Water Cooled Xenon Arc Apparatus

SAE J2260—Non-Metallic, Low-Permeation Fuel System Tubing with One or More Layers

2.1.2 ASTM Publications—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Method of Salt Spray (Fog) Testing

ASTM D 257—DC Resistance or Conductance of Insulating Materials

ASTM D 380—Methods of Testing Rubber Hose

ASTM D 412—Test for Rubber Properties in Tension

ASTM D 413—Test Methods for Rubber Property: Adhesion to Flexible Substrate

ASTM D 471—Test for Rubber Property: Effect on Liquids

ASTM D 573—Test for Rubber: Deterioration in an Air Oven

ASTM D 1149—Test Method for Rubber Deterioration: Surface Ozone Cracking in a Chamber (Flat Specimens)

2.1.3 RMA Publication—Available from Rubber Manufacturers Association, 1400 K Street, NW, Suite 900, Washington D.C. 20005.

RMA IP-2—Method for Measuring Electrical Resistance of Hose

3. Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R2)

3.1 Hose Construction

3.1.1 Type 1—The construction of this hose embodies a smooth bore tube of suitable synthetic rubber material, reinforced with one ply of braided, knit, spiral, or woven fabric, and finished with a suitable oil- and ozone-resisting synthetic rubber cover.

3.1.2 Type 2—The construction of this hose embodies a smooth bore tube of suitable synthetic rubber material, reinforced with two braided plies or multiples of woven fabric, and finished with a suitable oil- and ozone-resisting synthetic rubber cover.

3.1.3 Type 3—The construction of this hose embodies a smooth bore tube of suitable synthetic rubber material, a single braided ply of textile reinforcement, and finished with a suitable oil- and ozone-resisting synthetic rubber cover.

3.2 Dimensions—Dimensions and tolerances are shown in Table 1.

3.3 Retests and Rejection—Any hose or assembly that fails in one or more tests shall be resampled and retested. Twice the number of specimens shall be selected from the lot in question for any retests, and failure of any of the retested samples shall be cause for rejection.

3.4 Tests

3.4.1 Qualification Tests—For qualification tests, one 7.6 m (25 ft) length of bulk hose or 10 assemblies of each size to be qualified shall be furnished. In order to qualify under this standard, hose and hose assemblies must meet the requirements of the following tests: (a) change-in-length followed by (b) burst, (c) vacuum collapse, (d) cold flexibility, (e) tensile strength and elongation, tube and cover, (f) dry heat resistance, (g) fuel resistance, (h) oil resistance, (i) ozone resistance, and (j) adhesion.

TABLE 1—DIMENSIONS AND TOLERANCES FOR SAE 30R2

Nominal Size mm	Nominal Size in	Inside Diameter in	Inside Diameter mm	Outside Diameter(1) Types 1 and 3 mm Min	Outside Diameter(1) Types 1 and 3 mm Max	Outside Diameter(1) Types 1 and 3 in Min	Outside Diameter(1) Types 1 and 3 in Max	Outside Diameter(1) Type 2 Min	Outside Diameter(1) Type 2 mm Max	Outside Diameter(1) Type 2 in Min	Outside Diameter(1) Type 2 in Max
3.18	1/8	3.18 ± 0.25	0.125 ± 0.010	8.33	9.53	0.328	0.375	11.13	12.70	0.438	0.500
4.78	3/16	4.78 ± 0.40	0.188 ± 0.016	9.93	11.13	0.391	0.438	12.70	14.27	0.500	0.562
6.35	1/4	6.35 ± 0.40	0.250 ± 0.016	11.51	12.70	0.453	0.500	14.27	15.88	0.562	0.625
7.92	5/16	7.92 ± 0.40	0.312 ± 0.016	13.11	14.27	0.516	0.562	15.88	17.48	0.625	0.688
9.53	3/8	9.53 ± 0.40	0.375 ± 0.016	14.68	15.88	0.578	0.625	17.48	19.05	0.688	0.750
11.13	7/16	11.13 ± 0.58	0.438 ± 0.023	—	—	—	—	19.05	20.62	0.750	0.812
12.70	1/2	12.70 ± 0.58	0.500 ± 0.023	18.26	19.84	0.719	0.781	20.62	22.23	0.812	0.875
15.88	5/8	15.88 ± 0.58	0.625 ± 0.023	21.44	23.01	0.844	0.906	23.83	25.40	0.938	1.000
19.05	3/4	19.05 ± 0.58	0.750 ± 0.023	26.97	28.58	1.062	1.125	26.97	28.58	1.062	1.125
22.23	7/8	22.23 ± 0.79	0.875 ± 0.031	—	—	—	—	30.18	31.75	1.188	1.250
25.40	1	25.40 ± 0.79	1.000 ± 0.031	32.54	34.93	1.281	1.375	32.54	34.93	1.281	1.375
28.58	1-1/8	28.58 ± 0.79	1.125 ± 0.031	—	—	—	—	38.10	41.28	1.500	1.625
31.75	1-1/4	31.75 ± 0.99	1.250 ± 0.039	—	—	—	—	41.28	44.45	1.625	1.750
34.93	1-3/8	34.93 ± 0.99	1.375 ± 0.039	—	—	—	—	44.45	47.63	1.750	1.875
38.10	1-1/2	38.10 ± 0.99	1.500 ± 0.039	—	—	—	—	47.63	50.80	1.875	2.000
41.28	1-5/8	41.28 ± 0.99	1.625 ± 0.039	—	—	—	—	50.80	53.98	2.000	2.125
44.45	1-3/4	44.45 ± 0.99	1.750 ± 0.039	—	—	—	—	53.98	57.15	2.125	2.250
50.80	2	50.80 ± 0.99	2.000 ± 0.039	—	—	—	—	60.33	63.50	2.375	2.500

1. Concentricity based on total indicator reading between the inside bore of the hose and the outer surface of the hose shall not exceed the values given below:
   Sizes 1/4 in and under: 0/76 mm (0.030 in)
   Sizes over 1/4 up to 7/8 in: 1.02 mm (0.040 in)
   Sizes over 7/8 in: 1.27 mm (0.050 in)

In addition to the above, hose assemblies shall be subjected to qualification tests as follows: (k) proof, (l) tensile test of assembly, (m) leakage, (n) corrosion, and (o) visual inspection.

3.4.2 FREQUENCY OF TESTING FOR INSPECTION—On uncoupled hose, tests shall be conducted on samples representing each lot of 152 to 3048 m (500 to 10 000 ft). Where a lot is 152 m (500 ft) or less, no tests shall be conducted, but materials and workmanship shall be the same on such lots as on hose previously qualified under this specification.

On coupled hose lots from 100 to 10 000 pieces, not less than two assemblies shall be subjected to all inspection tests except the visual test, which shall apply to 100% of the assemblies.

3.4.3 INSPECTION TESTS—On coupled hose, these inspection tests shall apply: (a) change-in-length, (b) burst, (c) vacuum collapse, (d) cold flexibility, and (e) adhesion.

On coupled hose assemblies, these tests shall apply: (f) burst, (g) proof, (h) tension test of assembly (unaged), and (i) visual inspection (100%).

3.5 Test Requirements

3.5.1 CHANGE-IN-LENGTH TESTS—Tests for change in length shall be conducted in accordance with ASTM D 380, except that the original measurement shall be at 0 MPa (0 psi) pressure. The change in length shall be determined at the pressures specified in Table 2. Requirements are as follows:

3.5.1.1 Type 1—All sizes ±5% maximum.

3.5.1.2 Type 2—Up to 12.70 mm (1/2 in) ID hose, 0 to −8% change in length; 12.70 mm (1/2 in) ID hose and larger, 0 to −6% change in length.

3.5.1.3 Type 3—All sizes, ±5% maximum.

3.5.2 BURST TEST—The minimum bursting strength shall be as specified in Table 2.

3.5.3 VACUUM COLLAPSE TEST—Types 1 and 3: Sizes less than 12.70 mm (1/2 in) ID shall be subjected to 67.5 kPa (20 in Hg) vacuum; 12.70 mm (1/2 in) ID hose shall be subjected to 34 kPa (10 in Hg) vacuum. Sizes greater than 12.70 mm (1/2 in) ID shall be excluded from the vacuum test.

3.5.3.1 Type 2—Sizes less than 15.88 mm (5/8 in) ID shall be subjected to 67.5 kPa (20 in Hg) vacuum. Hose 15.88 mm (5/8 in) through 25.40 mm (1 in) ID shall be subjected to 34 kPa (10 in Hg) vacuum; sizes greater than 25.40 mm (1 in) ID shall be excluded from the vacuum test.

During the vacuum test described, a 915 mm (3 ft) length of hose or a hose assembly shall be held in a straight line, and no diameter shall decrease by more than 20% during application of vacuum for 15 s and not over 30 s.

3.5.4 COLD FLEXIBILITY—Hose 19.05 mm (3/4 in) ID and under, with or without couplings, shall be used for this test. Two samples shall be used for this test. One sample shall be unaged and the other sample shall be immersed in ASTM Oil No. 3 for 70 h at 100 °C ± 1 °C (212 °F ± 2 °F). The aged and unaged samples shall then be subjected to a temperature of −40 °C ± 1 °C (−40 °F ± 2 °F) for a period of 5 h, after which the hose shall be flexed in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. This flexing shall be within 4 s. The hose shall not fracture and shall not show any cracks, checks, or breaks in the tube or cover. Cracking of the tube may be determined by application of the proof pressure specified in Table 2.

Hose over 19.05 mm (3/4 in) ID shall have specimens 100 x 6.4 mm (4 x 0.25 in) tube and cover thickness. The thickness shall be 2.54 mm (0.10 in) maximum. Cut from the tube and cover if necessary. One set of samples shall be unaged. The other set of samples shall be completely immersed in ASTM Oil No. 3 for 70h at 100 °C ± 1 °C (212 °F ± 2 °F). The unaged and aged specimens shall then be subjected to a temperature of −40 °C ± 1 °C (−40 °F ± 2 °F) for a period of 5 h in an unrestrained loop position between two jaws 50 mm (2 in) wide and 63 mm (2-1/2 in) apart. At the end of 5 h and while still in the cold chamber, the jaws shall be rapidly brought together until they are 25.40 mm (1 in) apart. The specimen shall not fracture and shall not show any cracks, checks, or breaks.

3.5.5 TENSILE STRENGTH AND ELONGATION

a. Original tensile strength of cover: 6.89 MPa (1000 psi) min

b. Original tensile strength of tube: 8.27 MPa (1200 psi) min

c. Original elongation of tube and cover: 200% min

3.5.6 DRY HEAT RESISTANCE—After oven aging for 70 h at a temperature of 100 °C ± 1 °C (212 °F ± 2 °F), the reductions in tensile strength and elongation of specimens taken from the tube and cover shall not exceed the following values:

a. Original tensile strength: −20%

b. Original elongation: −50%

3.5.7 FUEL RESISTANCE

3.5.7.1 After 48 h immersion at room temperature in ASTM Reference Fuel B, the reductions in tensile strength and elongation of specimens taken from the tube shall not exceed the following values:

a. Original tensile strength: −30%

b. Original elongation: −30%

3.5.7.2 In addition, the volume change of specimens taken from the tube shall not exceed the following values:

a. Tube, volume change: −5 to +25%

3.5.8 OIL RESISTANCE

3.5.8.1 After 70 h immersion at a temperature of 100 °C ± 1 °C (212 °F ± 2 °F) in ASTM Oil No. 3, the reduction in tensile strength and elongation of specimens taken from the tube shall not exceed the following values:

a. Original tensile strength: −40%

b. Original elongation: −40%

3.5.8.2 In addition, the volume change of specimens taken from the tube and cover shall not exceed the following values:

a. Tube, volume change: −5 to +25%

b. Cover, volume change: 0 to +100%

TABLE 2—BURST AND CHANGE-IN-LENGTH TESTS FOR SAE 30R2

Nominal Size mm	Nominal Size in	Burst Test, min Type 1 MPa	Burst Test, min Type 1 psi	Burst Test, min Type 2 MPa	Burst Test, min Type 2 psi	Burst Test, min Type 3 MPa	Burst Test, min Type 3 psi	Change-in-Length Test Types 1 and 2 MPa	Change-in-Length Test Types 1 and 2 psi	Change-in-Length Test Type 3 MPa	Change-in-Length Test Type 3 psi
3.18	1/8	4.82	700	4.82	700	—	—	0.79	115	—	—
4.78	3/16	4.82	700	4.82	700	13.80	2000	0.79	115	3.45	500
6.35	1/4	4.82	700	4.82	700	11.04	1600	0.79	115	2.76	400
7.92	5/16	4.82	700	4.82	700	11.04	1600	0.79	115	2.76	400
9.53	3/8	4.82	700	4.82	700	11.04	1600	0.79	115	2.76	400
11.13	7/16	4.82	700	4.82	700	—	—	0.79	115	—	—
12.70	1/2	4.82	700	4.82	700	11.04	1600	0.79	115	2.76	400
15.88	5/8	3.45	500	3.45	500	9.66	1400	0.59	85	2.42	350
19.05	3/4	3.45	500	3.45	500	8.27	1200	0.59	85	2.07	300
22.23	7/8	—	—	3.45	500	—	—	0.59	85	—	—
25.40	1	3.45	500	3.45	500	—	—	0.59	85	—	—
28.58	1-1/8	—	—	2.76	400	—	—	0.45	65	—	—
31.75	1-1/4	—	—	2.76	400	—	—	0.45	65	—	—
34.93	1-3/8	—	—	2.76	400	—	—	0.45	65	—	—
38.10	1-1/2	—	—	2.76	400	—	—	0.45	65	—	—
41.28	1-5/8	—	—	1.73	250	—	—	0.28	40	—	—
44.45	1-3/4	—	—	1.73	250	—	—	0.28	40	—	—
50.80	2	—	—	1.73	250	—	—	0.28	40	—	—

3.5.9 OZONE RESISTANCE—Test procedure shall be in accordance with ASTM D 1149 where applicable.

For hose 25.40 mm (1 in) ID and under, a specimen of hose of sufficient length shall be bent around a mandrel with an outside diameter equal to eight times the nominal OD of the sample. The two ends shall be tied at their crossing with enameled copper or aluminum wire. After mounting, the specimen shall be allowed to rest in an ozone-free atmosphere for 24 h at room temperature. The mounted specimens shall be placed in a test chamber with ozone concentration of 50 mPa at a temperature of 40 °C ± 1 °C (104 °F ± 2 °F).

After 70 h of exposure, the specimen shall be removed and allowed to cool to room temperature and then be inspected visually under 7X magnification. It must meet a rating of "0" except for the area immediately adjacent to the wire, which shall be ignored.

For hose over 25.40 mm (1 in) ID, prepare a specimen by cutting a strip of the whole hose 12.70 x 100 mm (1/2 wide by 4 in long) and tie to a specimen (cover out) around a 12.70 mm (1/2 in) diameter mandrel. Condition in the same manner as specified in the previous paragraphs for the whole hose and apply the same conditions and requirements. This test applies to the cover only and cracks in the exposed tube or cut edges of the cover shall be ignored.

3.5.10 ADHESION TEST

3.5.10.1 Types 1 and 3—The minimum load required to separate tube from reinforcing ply and cover from reinforcing ply shall be 27 N (6 lb).

3.5.10.2 Type 2—The minimum load required to separate tube from ply, cover from ply, and ply from ply shall be 53.4 N (12 lb).

3.5.11 PROOF TEST—Before shipment by the vendor, a suitable number of assemblies from each lot shall be proof tested at 50% of the minimum burst pressure specified in Table 2 for a period of not less than 30 s or more than 60 s, to ensure an acceptable quality level.

3.5.12 TENSILE TEST OF ASSEMBLY—The hose complete with fittings shall be dry-air aged at 100 °C ± 1 °C (212 °F ± 2 °F) for 70 h and then permitted to rest at room temperature for 2 h. The end fittings of the assembly shall be clamped in the jaws of a tension testing machine so that a straight pull may be applied. The jaws of the test machine shall separate at a rate not greater than 25.40 mm (1 in) min. The hose assembly shall withstand, after the aging test, a minimum pull of 444 N (100 lb) on sizes up to, and including, the 6.35 mm (1/4 in). All sizes over 6.35 mm (1/4 in) ID shall withstand a minimum pull of 667 N (150 lb). For inspection tests, unaged samples may be used.

3.5.13 LEAKAGE TEST

3.5.13.1 Types 1 and 2—Coupled hose shall show no leakage under a hydrostatic pressure of 70% of the minimum burst specified in Table 2, following an aging period of 70 h at 100 °C ± 1 °C (212 °F ± 2 °F) oven temperature. The pressure shall be held for a period of not less than 5 min or more than 7 min.

3.5.13.2 Type 3—Coupled hose shall show no leakage under a hydrostatic pressure of 50% of the minimum burst specified in Table 2, following an aging period of 70 h at 100 °C ± 1 °C (212 °F ± 2 °F) oven temperature. The pressure shall be held for a period of not less than 5 min or more than 7 min.

3.5.14 CORROSION TEST—The assembly shall be tested in accordance with ASTM B 117. The period shall be 48 h. There shall be no evidence of corrosion or other deterioration at the expiration of this test.

3.5.15 VISUAL INSPECTION—All assemblies shall be inspected to see that the correct fittings are properly applied.

4. Lightweight Braided Reinforced Lacquer, Cement, or Rubber Covered Hose (SAE 30R3)

4.1 Hose Construction—The construction of this hose embodies a smooth bore tube of suitable synthetic rubber material, reinforced with one braided ply of cotton or other suitable material and finished with a gasoline-, oil-, and water-resistant flexible coating of lacquer, cement, or synthetic rubber.

4.2 Dimensions—Dimensions and tolerances are shown in Table 3.

4.3 Retests and Rejection—Any hose or assembly that fails in one or more tests shall be resampled and retested. Twice the number of specimens shall be selected from the lot in question for any retests, and failure of any of the retested samples shall be cause for rejection.

4.4 Tests—Procedures described in ASTM D 380 shall be followed wherever applicable.

4.4.1 QUALIFICATION TESTS—For qualification tests, one 7.6 m (25 ft) length of bulk hose or 10 assemblies of each size to be qualified shall be furnished. In order to qualify under this specification, hose and hose assemblies must meet the requirements of the following tests: (a) change-in-length followed by (b) burst, (c) vacuum collapse, (d) cold flexibility, (e) tensile strength and elongation of tube, (f) dry heat resistance, (g) fuel resistance, (h) oil resistance, and (i) ozone resistance.

In addition to the previous tests, hose assemblies shall be subjected to qualification tests as follows: (j) proof, (k) tensile test of assembly, (l) leakage, (m) corrosion, and (n) visual inspection.

4.4.2 FREQUENCY OF TESTING FOR INSPECTION—On uncoupled hose, tests shall be conducted on samples representing each lot of 152 to 3048 m (500 to 10 000 ft). Where a lot is 152 m (500 ft) or less, no tests shall be conducted, but materials and workmanship shall be the same on such lots as on hose previously qualified under this specification.

On coupled hose lots of 100 to 10 000 pieces, not less than two assemblies shall be subjected to all inspection tests except the visual test, which shall apply to 100% of the assemblies.

4.4.3 INSPECTION TESTS—On uncoupled hose, these inspection tests shall apply: (a) change-in-length, (b) vacuum collapse, and (c) cold flexibility.

On coupled hose assemblies, these tests shall apply: (d) burst, (e) proof, (f) tension test of assembly (unaged), and (g) visual inspection (100%).

4.5 Test Requirements

4.5.1 CHANGE-IN-LENGTH TESTS—Tests for change in length shall be conducted in accordance with ASTM D 380, except that the original measurement shall be made at 0 MPa (0 psi) pressure. The change in length shall not exceed ±5% at the change-in-length pressures specified in Table 4.

4.5.2 BURST TEST—The minimum bursting strength shall be as specified in Table 4.

4.5.3 VACUUM COLLAPSE TEST—Two assemblies shall be subjected to a vacuum of 67.5 kPa (20 in Hg), and the reduction in OD shall not exceed 20% of the original diameter during application of vacuum for 15 s and not over 30 s. Tests shall be conducted with hose in a straight position.

4.5.4 COLD FLEXIBILITY—Two samples shall be used for this test. One sample shall be unaged and the other sample shall be immersed in ASTM Oil No. 3 for 70 h at 100 °C ± 1 °C (212 °F ± 2 °F). The aged and unaged samples shall then be subjected to a temperature of –40 °C ± 1 °C (–40 °F ± 2 °F) for a period of 5 h, after which the hose shall be flexed in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. This flexing shall be within 4 s. The hose shall not fracture and shall not show any cracks, checks, or breaks in the tube or cover. Cracking of the tube may be determined by application of the proof pressure specified in Table 4.

4.5.5 TENSILE STRENGTH AND ELONGATION

a. Original tensile strength of tube: 8.27 MPa (1200 psi) min

b. Original elongation of tube: 200% min

4.5.6 DRY HEAT RESISTANCE—After oven aging for 70 h at a temperature of 100 °C ± 1 °C (212 °F ± 2 °F), the reductions in tensile strength and elongation of specimens taken from the tube shall not exceed the following values:

a. Original tensile strength: –20%

b. Original elongation: –50%

TABLE 3—DIMENSIONS AND TOLERANCES FOR SAE 30R3

Nominal Size mm	Nominal Size in	Inside Diameter mm	Inside Diameter in	Outside Diameter (1) Min mm	Outside Diameter(1) Min in	Outside Diameter(1) Max mm	Outside Diameter(1) Max in
4.76	3/16	4.76 ± 0.40	0.188 ± 0.016	8.73	0.344	9.53	0.375
6.35	1/4	6.35 ± 0.40	0.250 ± 0.016	10.32	0.406	11.13	0.438
7.94	5/16	7.94 ± 0.40	0.312 ± 0.016	12.70	0.500	13.49	0.531
9.53	3/8	9.53 ± 0.40	0.375 ± 0.016	14.68	0.578	15.88	0.625

1. Concentricity based on total indicator reading between the inside bore of the hose and the outer surface of the hose shall not exceed the following values:
   Size 1/4 in and under: 0.762 mm (0.030 in)
   Size over 1.016 mm: 1/4 in (0.040 in)

TABLE 4—BURST, HYDROSTATIC, AND CHANGE-IN-LENGTH TESTS FOR SAE 30R3

Nominal Size mm	Nominal Size in	Burst Test, min MPa	Burst Test, min psi	Hydrostatic Proof MPa	Hydrostatic Proof psi	Change-in-Length MPa	Change-in-Length psi
4.76	3/16	13.80	2000	6.89	1000	3.45	500
6.35	1/4	11.04	1600	5.51	800	2.76	400
7.94	5/16	8.27	1200	4.14	600	2.07	300
9.53	3/8	6.20	900	3.10	450	1.53	225

4.5.7 Fuel Resistance

4.5.7.1 After 48 h immersion at room temperature in ASTM Reference Fuel B, the reductions in tensile strength and elongation of specimens taken from the tube shall not exceed the following values:

a. Original tensile strength: –30%
b. Original elongation: –30%

4.5.7.2 In addition, the volume change of specimens taken from the tube shall not exceed the following values:

a. Tube, volume change: –5 to +25%

4.5.8 Oil Resistance

4.5.8.1 After 70 h immersion at a temperature of 100 °C ± 1 °C (212 °F ± 2 °F) in ASTM Oil No. 3, the reductions in tensile strength and elongation of specimens taken from the tube shall not exceed the following values:

a. Original tensile strength: –40%
b. Original elongation: –40%

4.5.8.2 In addition, the volume change of specimens taken from the tube shall not exceed the following values:

a. Tube, volume change: –5 to +25%

4.5.9 Ozone Resistance—Test procedure shall be in accordance with ASTM D 1149, where applicable.

A specimen of hose of sufficient length shall be bent around a mandrel with an OD equal to eight times the nominal OD of the sample. The two ends shall be tied at their crossing with enameled copper or aluminum wire. After mounting, the specimen shall be allowed to rest in an ozone-free atmosphere for 24 h at room temperature. The mounted specimen shall be placed in a test chamber with ozone concentration of 50 mPa at a temperature of 40 °C ± 1 °C (104 °F ± 2 °F).

After 70 h of exposure, the specimen shall be removed and allowed to cool to room temperature and then be inspected visually under 7X magnification. It must meet a rating of "0" except for the area immediately adjacent to the wire, which shall be ignored.

4.5.10 Proof Test—Before shipment by the vendor, a suitable number of assemblies from each lot shall be tested at the hydrostatic proof pressure listed in Table 4 for a period of not less than 30 s or more than 60 s, to ensure an acceptable quality level.

4.5.11 Tensile Test Of Assembly—The hose complete with fittings shall be dry aged at 100 °C ± 1 °C (212 °F ± 2 °F) for 70 h and then permitted to rest at room temperature for 2 h. The end fittings of the assembly shall be clamped in the jaws of a tension testing machine so that a straight pull may be applied. The jaws of the test machine shall separate at a rate not greater than 25.40 mm (1 in)/min. The hose assembly shall withstand, after the aging test, a minimum pull of 444 N (100 lb) on the 4.76 mm (3/16 in) size, 556 N (125 lb) on the 6.35 and 7.94 mm (1/4 and 5/16 in) sizes, and 667 N (150 lb) on the 9.53 mm (3/8 in) size. For inspection tests, unaged samples may be used.

4.5.12 Leakage Test—Coupled hose filled with ASTM Oil No. 3 shall show no leakage under the hydrostatic proof test pressure specified in Table 4 following an aging period of 70 h at 100 °C ± 1 °C (212 °F ± 2 °F). The pressure shall be held for a period of not less than 5 min or more than 7 min.

4.5.13 Corrosion Test—The assembly shall be tested in accordance with ASTM B 117. The period shall be 48 h. There shall be no evidence of corrosion or other deterioration at the expiration of this test.

4.5.14 Visual Inspection—All assemblies shall be inspected to see that the correct fittings are properly applied.

5. ***Wire Inserted Synthetic Rubber Tube and Cover (SAE 30R5)***—This section covers a wire inserted hose for fuel and oil filler and vent use in mobile, stationary, or marine applications. The hose is furnished uncoupled in specific lengths and is secured in application by the use of suitable clamps. The hose is particularly useful in applications where it must be installed in a curved configuration and where resistance to collapse is desirable.

5.1 Hose Construction—The hose will consist of a fuel- and oil-resistant tube, a helical high-carbon steel wire embedded in the convoluted section of this hose and running out into the plain[1] ends and an ozone- and oil-resistant cover. A ply of fabric or cord may be applied between the tube or cover and the helical wire. A ply of fabric must be used to reinforce the ends.

5.2 Dimensions and Tolerances—The applicable dimensions and tolerances are shown in Table 5.

5.3 Physical Tests

5.3.1 The minimum burst shall be 0.621 MPa (90 psi) for all sizes.

5.3.2 Test samples for other physical properties shall be taken from the plain[2] ends and shall be conducted per ASTM D 380 unless otherwise agreed upon between vendor and purchaser.

The physical properties of the tube and cover shall be as shown in Table 6.

5.4 Low-Temperature Flexibility—Specimens of the plain end shall be cut 25.40 mm (1 in) wide. They shall be exposed in a cold box for 5 h at –40 °C ± 1 °C (–40 °F ± 2 °F). Without removing it from the cold box, the specimen shall be compressed to 50% of its original ID between parallel plates in 8 to 12 s. After removal and allowing it to come to room temperature, it shall be carefully examined visually. Any evidence of crack or breaking shall be cause for rejection.

5.5 Vacuum Collapse—The hose shall be subjected to 67.5 kPa (20 in-Hg) vacuum. During the test, the entire hose shall be mounted on suitable nipples. The OD shall not collapse more than 20% in the body section and there shall be no evidence of separation of the tube from the body wire when examined after application of the vacuum for 30 to 60 s.

5.6 Ozone Test—Due to the construction and application of this type of hose, ozone deterioration of the cover is particularly significant. The test procedure shall be in accordance with ASTM D 1149 where applicable. The entire hose or a section removed therefrom shall be used as agreed between supplier and user and the specimen shall be mounted as agreed. After mounting, the specimen shall be allowed to rest in an ozone-free atmosphere for 24 h at room temperature. This shall then be placed in a test chamber with ozone concentration of 50 mPa at a temperature of 40 °C ± 1 °C (104 °F ± 2 °F).

TABLE 5—DIMENSIONS AND TOLERANCES FOR SAE 30R5

Nominal ID mm	Nominal ID in	Tolerance mm	Tolerance in	Wall mm	Wall in	Length mm	Length in	Tolerance mm	Tolerance in
19.05	3/4	+0.76-1.52	+0.03-0.06	3.05/5.89	0.12/0.22	0–305	0 thru 12	±6.35	±0.25
25.40	1	+0.76-1.52	+0.03-0.06	3.05/5.89	0.12/0.22	305–610	Over 12 thru 24	±12.70	±0.50
31.75	1-1/4	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	610–915	Over 24 thru 36	±19.05	±0.75
38.10	1-1/2	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	915	Over 36	±2%	±2%
44.45	1-3/4	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	—	—	—	—
50.80	2	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	—	—	—	—
57.35	2-1/4	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	—	—	—	—
63.50	2-1/2	+0.76 -2.28	+0.03 -0.09	3.05/5.89	0.12/0.22	—	—	—	—

The minimum tube gage for all sizes shall be 1.57 mm (0.062 in).

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[1] Synonyms may be "straight ends" or "soft ends."

[2] Synonyms may be "straight ends" or "soft ends."

TABLE 6—PHYSICAL PROPERTIES OF 30R5 TUBE AND COVER

Property	Tube	Cover
Original tensile, min	8.27 MPa (1200 psi)	6.89 MPa (1000 psi)
Original elongation, min, %	200	200
Tensile after oven aging 100 h at 100 °C ± 1 °C (212 °F ± 2 °F) (ASTM D 573), min, % of original	80	80
Elongation after oven aging 100 h at 100 °C ± 1 °C (212 °F ± 2 °F) (ASTM D 573), min, % of original	70	80
Tensile after immersion in Fuel B, 48 h (ASTM D 471), min, % of original	70	Not required
Elongation after immersion in Fuel B, 48 h (ASTM D 471), min, % of original	70	Not required
Volume change after immersion in Fuel B, 48 h (ASTM D 471), %	−5 to +25	Not required
Tensile after immersion in ASTM No. 3 Oil, 70 h at 100 °C ± 1 °C (212 °F ± 2), min, % of original	60	Not required
Elongation after immersion in ASTM No. 3 Oil, 70 h at 100 °C ± 1 °C (212 °F ± 2), min, % of original	60	Not required
Volume change after immersion in ASTM No. 3 Oil, 70 h at 100 °C ± 1 °C (212 °F ± 2), %	−5 to +25	0 to +100

After 70 h exposure, the specimen shall be removed and allowed to cool to room temperature and then shall be inspected visually under 7X magnification. It must meet a rating of "0" except for areas which have been agreed can be ignored.

5.7 Qualification and Inspection Testing—For qualifications, 10 lengths of each size to be qualified shall be furnished and shall be subjected to all tests as described in 5.3 to 5.6. For inspection testing, not less than two samples shall be selected from each lot which shall not exceed 10 000 pieces and shall be subjected to the burst, vacuum collapse, and low-temperature flexibility tests described above. Any hose that fails in one or more tests shall be resampled and retested. Twice the number of specimens shall be selected from the lot in question for any retest. Failure of any of the retest samples shall be cause for rejection.

6. Low-Pressure Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R6)[3], (SAE 30R7), (SAE 30R8)—This section covers hose which may be supplied either coupled or uncoupled for use with gasoline, diesel fuel, lubrication oil, or the vapor present in either the fuel system or in the crankcase of internal combustion engines in mobile, stationary, and marine applications. Exposure of these hoses to gasoline or diesel fuel which contain high levels, greater than 5% by volume, of oxygenates, i.e., ethanol, methanol, or MTBE (methyl tertiary butyl ether), may result in significantly higher permeation rates than those listed for 30R6, 7, or 8. This hose is for maximum working pressures of 0.34 MPa (50 psi) up to and including 9.53 mm (3/8 in) ID and 0.24 MPa (35 psi) for over 9.53 mm (3/8 in). For 30R6 hose in excess of 25.40 mm (1 in), the working pressure is 0.11 MPa (16 psi). The hose may be furnished in long lengths, specific cut lengths, or as a part preformed to a specific configuration. This hose is suitable for use in temperatures up to 100 °C (212 °F) for 30R6, 125 °C (257 °F) for 30R7, 150 °C (302 °F) intermittently and 135 °C (275 °F) continuously for 30R8.

6.1 Hose Construction—The construction of this hose embodies a smooth bore tube of fuel- and oil-resistant synthetic rubber compound, suitably reinforced with textile fiber yarn, cord, or fabric, and a cover of suitable oil-, ozone-, and heat-resistant synthetic rubber compound.

6.2 Dimensions

6.2.1 Dimensions and tolerances for inside diameter and outside diameter are shown in Table 7. The ends of hose shall be square within 3.00 mm (0.12 in) for sizes up to and including 19.05 mm (3/4 in) ID, 6.35 mm (0.25 in) for sizes 25.40 mm (1 in) through 50.80 mm (2 in) ID, and 9.5 mm (0.38 in) for sizes over 50.80 mm (2 in) ID. Other tolerances applicable are as in Table 8.

6.2.2 When hose is supplied in specific cut or long lengths, the length tolerances shall be as in Table 8.

6.2.2.1 End squareness shall be measured from a point projected from the short side to the inside of the long side by a line perpendicular to the wall of the hose, to the end of the hose at its longest point. End squareness measurement will be considered equally applicable with length tolerance. The midpoint of the measurement of the deviation from squareness taken on the long side shall fall within the length tolerance.

6.2.3 When hose is supplied as a preformed item, the tolerance shall be as follows:

6.2.3.1 Squareness of Ends—The tolerance on squareness of ends of preformed parts shall be a minimum 15% of nominal hose OD on all sizes through 25.40 mm (1 in) ID, 6.3 mm (0.25 in) for sizes over 25.40 mm (1 in) ID through 50.80 mm (2 in) ID and 9.5 mm (0.38 in) for sizes over 50.80 mm (2 in) ID. End squareness shall be measured as described in 6.2.2.1.

6.2.3.2 Arm Lengths—Measured from end to intersection of nearest centerline. Each end shall be as described in 6.2.2. These tolerances apply also to the length of an expanded end.

6.2.3.3 General Layout—Dimensions locating bend intersections are to establish the theoretical centerline of the hose. Actual outside contour on the hose must be held within 4.8 mm (0.19 in) in all planes with respect to the theoretical outside contour. To check contour, hose ends should first be placed in nominal position (hose may have to be flexed to correct any distortion caused by handling after vulcanization in the producing plant or in shipment) in a checking fixture made in accordance with user requirement from which contour deviation can be measured. Allowance shall be provided in the end mounting area of the fixture for the arm length tolerances which are applicable.

When the ID of an end of the hose is enlarged, the wall gauge of the enlarged end normally changes. Allowable change should be +0.8, −0.5 mm (+0.03, −0.02 in). The wall gauge within bends of a preformed hose may differ from the gauge in straight portions. This difference shall not exceed 33%.

6.3 Retests and Rejection—Any hose or assembly that fails in one or more tests shall be resampled and retested. Twice the number of specimens shall be selected from the lot in question for any retests, and failure of any of the retested specimens shall be cause for rejection.

6.4 Tests—Procedures described by ASTM D 380 are to be followed wherever applicable.

6.4.1 QUALIFICATION TESTS—For the qualification tests, one 7.5 m (24.6 ft) length of bulk hose, 10 preformed parts, or 10 assemblies of each size to be qualified shall be furnished. In order to qualify under this specification, hose and hose assemblies must meet all the test requirements of 6.5.

6.4.2 FREQUENCY OF TESTING FOR INSPECTION—As agreed upon between supplier and user.

6.4.3 INSPECTION TEST—On hose and/or hose assemblies the following inspection tests shall apply: (6.5.1) burst, (6.5.2) vacuum collapse, (6.5.3) cold flexibility, (6.5.10) adhesion, (6.5.11) kink resistance if specified. The kink resistance test shall not normally be required on preformed hose, but may be specified for straight sections of at least 300 mm (11.8 in) length.

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[3] SAE 30R1 — This specification is presently obsolete and has been superseded by SAE 30R6. (Information on SAE 30R1 was last printed in the 1982 Handbook. This information can be found in SAE J30d.)

TABLE 7—DIMENSIONS AND TOLERANCES FOR SAE 30R6, SAE 30R7, AND SAE 30R8

Nominal Size mm	Nominal Size in	Inside Diameter mm	Inside Diameter in	Outside Diameter(1) mm	Outside Diameter(1) in	Maximum End Out-of-Squareness Angle, Deg(2)
3.97	5/32	3.97 ± 0.40	0.156 ± 0.016	9.13 ± 0.58	0.360 ± 0.023	14.5
4.76	3/16	4.76 ± 0.40	0.188 ± 0.016	10.32 ± 0.58	0.406 ± 0.023	14.4
5.56	7/32	5.56 ± 0.40	0.219 ± 0.016	11.11 ± 0.58	0.438 ± 0.023	14.3
6.35	1/4	6.35 ± 0.40	0.250 ± 0.016	12.70 ± 0.58	0.500 ± 0.023	14.2
7.14	9/32	7.14 ± 0.40	0.281 ± 0.016	13.49 ± 0.58	0.531 ± 0.023	14.1
7.94	5/16	7.94 ± 0.40	0.312 ± 0.016	14.29 ± 0.58	0.562 ± 0.023	14.0
8.73	11/32	8.73 ± 0.40	0.344 ± 0.016	15.08 ± 0.58	0.594 ± 0.023	14.0
9.53	3/8	9.53 ± 0.40	0.375 ± 0.016	15.88 ± 0.58	0.625 ± 0.023	13.9
11.11	7/16	11.11 ± 0.58	0.438 ± 0.023	18.26 ± 0.79	0.729 ± 0.031	13.7
12.7	1/2	12.70 ± 0.58	0.500 ± 0.023	19.84 ± 0.79	0.781 ± 0.031	13.5
15.88	5/8	15.88 ± 0.79	0.625 ± 0.031	23.81 ± 0.79	0.938 ± 0.031	13.1
19.05	3/4	19.05 ± 0.79	0.750 ± 0.031	28.58 ± 0.79	1.125 ± 0.031	12.7
25.40	1	25.40 ± 0.79	1.000 ± 0.031	34.93 ± 1.59	1.375 ± 0.062	12.0
31.75	1-1/4	31.75 ± 0.99	1.250 ± 0.039	Not Specified(3)	Not Specified(3)	11.2
38.10	1-1/2	38.10 ± 0.99	1.500 ± 0.039	Not Specified(3)	Not Specified(3)	10.4
44.45	1-3/4	44.45 ± 0.99	1.750 ± 0.039	Not Specified(3)	Not Specified(3)	9.7
50.80	2	50.80 ± 0.99	2.000 ± 0.039	Not Specified(3)	Not Specified(3)	8.9
57.15	2-1/4	57.15 ± 0.99	2.250 ± 0.039	Not Specified(3)	Not Specified(3)	8.1
63.50	2-1/2	63.50 ± 0.99	2.500 ± 0.039	Not Specified(3)	Not Specified(3)	7.4

1. Concentricity based on total indicator reading between the inside bore of the hose and the outer surface of the hose shall not exceed the values given below:
   Sizes 1/4 in and under: 0.762 mm (0.030 in)
   Sizes over 1/4 in up to 1/2 in: 1.016 mm (0.040 in)
   Sizes over 1/2 in: 1.270 mm (0.050 in)
2. These values were determined by the equation:
   $A = 15\ \text{degrees} - K \times D$
   where:
   A = Maximum out-of-squareness angle
   K = 0.12 degree per mm of diameter (a slope factor derived from linear best-fit previous squareness requirement)
   D = Nominal inside diameter in millimeters
3. The wall gauge for sizes 1-1/4 to 2 in shall be between 4.32 to 5.89 mm (0.17 to 0.22), and for sizes 2-1/4 and 2-1/2 in, between 4.32 to 6.35 mm (0.17 to 0.25 in).

TABLE 8—CUT OR LONG LENGTH TOLERANCES FOR SAE 30R6, SAE 30R7, AND SAE 30R8

Length m	Length in	Precision mm	Precision in	Commercial mm	Commercial in
0-0.3	0–12	± 3.0	± 0.12	+9.5 - 3.0	+0.38 -0.12
Over 0.31-0.6	Over 12–24	± 4.8	± 0.19	+ 9.5 - 4.8	+ 0.38 -0.19
Over 0.61-0.9	Over 25–36	± 6.3	± 0.25	+ 12.7 - 6.3	+ 0.50 -0.25
Over 0.91–1.2	Over 36–48	± 9.5	± 0.38	+ 12.7 - 9.5	+ 0.50 -0.38
Over 1.21–1.8	Over 48–72	± 12.7	± 0.50	+ 19.0 - 12.7	+ 0.75 -0.50
Over 1.81	Over 72		± 1%		+ 2%

TABLE 9—COLD FLEXIBILITY, PHYSICAL, EXTRACTABLES, AND FUEL PERMEATION PROPERTIES

Specification	Cold Flex IRM 903	Dry Heat Resistance	Oil Resistance IRM 903	Fuel Resistance	Ethanol MOD Fuel Resistance	Extractables	Permeation Maximum Rate/24h(1)(2)	Oxidized Fuel Test
SAE 30R6								
Aging Temperature	100 °C (212 °F)	100 °C (212 °F)	100 °C (212 °F)	23 °C (73 °F)	23 °C (73 °F)			
Cold Temperature	–34 °C (–29 °F)							
Tube								
Tensile Change		–20%	–40%	–45%	–45%	—	—	
Elongation Change		–50%	–40%	–45%	–45%	—	—	
Volume Change		—	–5 to +25%	0 to +50%	0 to +50%	—	—	
Cover								
Tensile Change		–20%	—	—	—	—	—	
Elongation Change		–50%	—	—	—	—	—	
Volume Change		—	0 to +100%	—	—	—	—	
Extractables		—	—	—	—	7.75 gm/m2	—	
Permeation - Fuel C, 8		—	—	—	—	—	600 gm/m2	

TABLE 9—COLD FLEXIBILITY, PHYSICAL, EXTRACTABLES, AND FUEL PERMEATION PROPERTIES (continued)

Specification	Cold Flex IRM 903	Dry Heat Resistance	Oil Resistance IRM 903	Fuel Resistance	Ethanol MOD Fuel Resistance	Extractables	Permeation Maximum Rate/24h[(1)(2)]	Oxidized Fuel Test
Days total								
SAE 30R7								
Aging Temperature	125 °C (257°F)	125 °C (257 °F)	125 °C (257 °F)	23 °C (73 °F)	23 °C (73 °F)			40 °C (104°F)
Cold Temperature	–34 °C (–29 °F)							
Tube								
Tensile Change		–20%	–50%	–45%	–45%	—	—	–35%
Elongation Change		–60%	–50%	–45%	–45%	—	—	–40%
Volume Change		—	–5 to +30%	0 to +50%	0 to +50%	—	—	—
Cover								
Tensile Change		–20%	—	—	—	—	—	—
Elongation Change		–60%	—	—	—	—	—	—
Volume Change		—	0 to +75%	—	—	—	—	—
Extractables		—	—	—	—	5.00 gm/m²	—	—
Permeation - Fuel C, 8		—	—	—	—	—	550 gm/m²	—
Days total								
SAE 30R8								
Aging Temperature	150 °C (302 °F)	150 °C (302 °F)	150 °C (302 °F)	23 °C (73 °F)	23 °C (73 °F)			
Cold Temperature	–40 °C (–40 °F)							
Tube								
Tensile Change		–25%	–20%	–35%	35%	—	—	
Elongation Change		–50%	–50%	–35%	–45%	—	—	
Volume Change		—	–5 to +15%	0 to +35%	0 to +40%	—	—	
Cover								
Tensile Change		–25%	—	—	—	—	—	
Elongation Change		–50%	—	—	—	—	—	
Volume Change		—	0 to +15%	—	—	—	—	
Extractables		—	—	—	—	2.50 gm/m²	—	
Permeation - Fuel C, 8		—	—	—	—	—	200 gm/m²	
Days total								
SAE 30R9								
Aging Temperature	135 °C (275 °F)	150 °C (302 °F)	150 °C (302 °F)	23 °C (73 °F)	23 °C (73 °F)			40 °C (104 °F)
Cold Temperature	–34 °C (–29 °F)							
Tube								
Tensile Change		—	—	—	–40%	—	—	–30% Max
Elongation Change		—	—	—	–40%	—	—	–20% Max
Volume Change		—	—	+10% Max	0 to +15%	—	—	—
Cover								
Tensile Change		—	+100% Max	—	—	—	—	—
Elongation Change		—	—	—	—	—	—	—
Volume Change		—	—	—	—	—	—	—
Extractables		—	—	—	—	2.5 g/m²	—	—
Permeation - Fuel C, 8		—	—	—	—	—	15 g/m²	—
Days total								
SAE 30R10								
Aging Temperature	125 °C (257 °F)	125 °C (257 °F)	150 °C (302 °F)	23 °C (73 °F)	23 °C (73 °F)			40 °C (104 °F)
Cold Temperature	–34 °C (–20 °F)	–34 °C (–29 °F)		–34 °C (–29 °F)				
Tube								
Tensile Change		—	—	—	–40%	—	—	–30% Max
Elongation Change		—	—	—	–40%	—	—	–20% Max
Volume Change		—	—	+10% Max	0 to +15%	—	—	—
Cover								
Tensile Change		—	—	—	–40%	—	—	–30% Max
Elongation Change		—	—	—	–40%	—	—	–20% Max
Volume Change		—	—	+10% Max	0 to +15%	—	—	—
Extractables		—	—	—	—	2.5 g/m²		—
Permeation - Fuel C, 8		—	—	—	—	—	Not Required	—
Days total								

1. Total effective length of hose with end plugs inserted shall be 275 mm (10.8 in).
2. A round metal (aluminum or steel) control rod conforming to the dimensions shown in Table 10 for hose sizes 19.05 mm (3/4 in) ID and larger shall be inserted into hose ID as shown in Figure 1. The rod shall be positioned in the end plugs such that it will not contact the hose ID.

6.5 Test Requirements

6.5.1 BURST TEST

6.5.1.1 (30R6). The minimum burst for hose sizes through 9.53 mm (3/8 in) ID shall be 1.72 MPa (250 psi), for hoses over 9.53 mm (3/8 in) ID through 2.54 mm (1 in) ID shall be 1.20 MPa (175 psi), and for hose sizes over 25.40 (1 in) shall be 0.55 MPa (80 psi). These hoses would have maximum working pressures of 0.34 MPa (50 psi), 0.24 MPa (35 psi), and 0.11 MPa (16 psi), respectively.

6.5.1.2 (30R7 and 30R8). The minimum burst for hose sizes through 9.53 mm (3/8 in) ID shall be 1.72 MPa (250 psi) and for sizes over 9.53 (3/8 in) shall be 1.20 MPa (175 psi). These hoses would have maximum working pressures of 0.34 MPa (50 psi) and 0.24 MPa (35 psi), respectively.

6.5.2 VACUUM COLLAPSE TEST. Sizes less than 12.70 mm (1/2 in) ID shall be subjected to 81 kPa (24 in Hg) vacuum. Sizes 12.70 mm (1/2 in) through 25.40 mm (1 in) ID shall be subjected to 34 kPa (10 in Hg) vacuum. This requirement shall not apply to sizes larger than 25.40 mm (1 in) ID. During the vacuum test described, a 1 m (3.28 ft) length of hose or a hose assembly shall be held in a straight line, and no diameter shall decrease by more than 20% during application of vacuum for a minimum of 15 s and not more than 60 s. The vacuum collapse test on preformed parts should be performed on the finished part.

6.5.3 COLD FLEXIBILITY—For straight hose 19.05 mm (3/4 in) ID and under, the whole hose shall be used for this test. Two samples shall be used, one to be unaged and the other immersed in ASTM Oil No. 3 for 70 h at the required temperature (See Table 9). The unaged samples are conditioned at –40 °C ± 2 °C (–40 °F ± 3.6 °F) for 5 h and then flexed in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. The aged samples for 30R6 and 30R7 are conditioned at –34 °C ± 2 °C (–29.2 °F ± 3.6 °F) for 5 h and the aged samples for 30R8 are conditioned at –40 °C ± 2 °C (–40 °F ± 3.6 °F) for 5 h and then flexed in the cold chamber through 180 degrees from centerline to a diameter of 10 times the maximum OD of the hose. The flexing shall take place within 4 s and the hose must not fracture or show any cracks, checks, or breaks in the tube or cover. Proof pressure of 0.68 MPa (99 psi) may be applied to determine tube damage.

For straight hose over 19.05 mm (3/4 in) ID and all preformed hose, prepare six specimens 100 x 6 mm (4 x 0.25 in) from whole hose wall. One set of three shall be unaged and the other aged in ASTM Oil No. 3 for 70 h at the required temperature (See Table 9). The unaged set shall be conditioned for 5 h at –40 °C ± 2 °C (–40 °F ± 3.6 °F) in an unrestrained loop positioned between two jaws 50.8 mm (2 in) wide and 63.5 mm (2-1/2 in) apart. The aged samples for 30R6 and 30R7 shall be conditioned for 5 h at –34 °C ± 2 °C (–29.2 °F ± 3.6 °F) and the aged samples for 30R8 are conditioned for 5 h at –40 °C ± 2 °C (–40°F ± 3.6 °F) in an unrestrained loop position between two jaws 50.8 mm (2 in) wide and 63.5 mm (2-1/2 in) apart.

After conditioning per ASTM D 380 and while still in the cold chamber, the jaws shall be brought together as rapidly as possible until they are 25.40 mm (1 in) apart. The specimens shall not fracture nor show any cracks, checks, or breaks.

6.5.4 TENSILE STRENGTH AND ELONGATION

a. Original tensile strength of cover: 7.0 MPa (1020 psi) min
b. Original tensile strength of tube: 8.0 MPa (1160 psi) min
c. Original elongation of tube and cover: 200% min

6.5.5 DRY HEAT RESISTANCE—After heat aging per ASTM D 573 for 70 h at the required temperature (See Table 9), the reductions in tensile strength and elongation of specimens taken from the tube and cover shall not exceed the change in values as shown in Table 9.

6.5.6 FUEL RESISTANCE. After 48 h immersion at room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 in ASTM Reference Fuel C, physical values of specimens taken from the tube shall not exceed the change in values as listed in Table 9.

6.5.7 OIL RESISTANCE—After 70 h immersion at the required temperature (See Table 9) in ASTM Oil No. 3, per ASTM D 471, physical values of specimens taken from the tube and cover shall not exceed the change in values listed in Table 9.

6.5.8 TEST FOR EXTRACTABLES IN HOSE

6.5.8.1 Apparatus and Reagents

6.5.8.1.1 ASTM Fuel C (50 Toluene - 50 isooctane percent by volume).
6.5.8.1.2 Methanol, 99% minimum purity.
6.5.8.1.3 Gooch crucible.
6.5.8.1.4 Glass fiber filter, Grade 934AH.
6.5.8.1.5 Beaker
6.5.8.1.6 Heating unit
6.5.8.1.7 Metal control rod and end plugs (See Figure 1 and Table 10.)

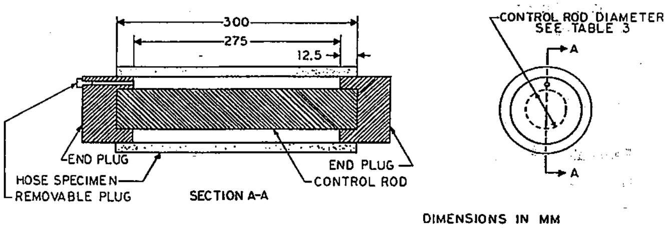

FIGURE 1—TEST FIXTURE FOR EXTRACTABLES

6.5.8.2 Specimens—Hose under test shall be 300 mm (11.8 in) long, plugged at both ends with metal (aluminum or steel) plugs to retain the fluid. Calculate inside surface area based on the actual inside diameter of the hose for its total effective length.

NOTE—Total effective length of hose with end plugs inserted shall be 275 mm (10.8 in).

NOTE—A round metal (aluminum or steel) control rod conforming to the dimensions shown in Table 10 for hose sizes 19.05 mm (3/4 in) ID and larger shall be inserted into hose ID as shown in Figure 1. The rod shall be positioned in the end plugs such that it will not contact the hose ID.

6.5.8.3 Procedure

6.5.8.3.1 Record hose actual inside diameter, length, and inside surface area. Preferred method is with plug ID gauges to nearest 0.025 mm (0.001 in).

6.5.8.3.2 Fill hose with ASTM Fuel C.

6.5.8.3.3 Allow to stand for 24 h at temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) with both ends sealed.

NOTE—Solubility of waxy hydrocarbons is affected by temperature.

6.5.8.3.4 Drain fluid from hose into a tared beaker.

6.5.8.3.5 Rinse inside of the specimen with an amount of fresh ASTM Fuel C approximately equal to the volume of the original filling and add to the original extraction.

6.5.8.3.6 Remove solvent by evaporation by heating at 80 to 95 °C (176 to 203 °F) until no fuel odor is detectable and then store sample at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) under a fume hood for a minimum of 16 h.

6.5.8.3.7 Take up residue with 30 mL of room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F), methanol.

6.5.8.3.8 Filter this solution on the tared crucible, rinsing beaker twice with 10 mL of room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F), methanol.

6.5.8.3.9 Place crucible in beaker and dry in a 65 to 90 °C (149 to 194 °F) oven to insure complete evaporation of methanol.

TABLE 10—CONTROL ROD DIMENSIONS

Hose Size (Nominal Inside Diameter) mm	Hose Size (Nominal Inside Diameter) in	Control Rod Diameter mm
Below 19.05	N/A	N/A
19.05	3/4	7.8
25.40	1	15.5
31.75	1 1/4	22.4
34.92	1 3/8	25.9
38.10	1 1/2	29.1
44.45	1 3/4	35.6
50.80	2	42.1
57.35	2 1/4	48.6
63.50	2 1/2	55.0

6.5.8.3.10 Weigh the gooch crucible and tared beaker and determine mass of extractables expressed as g/m^2 using surface area of hose in contact with ASTM Fuel C.

6.5.8.4 Value for total g/m^2 shall be values shown in Table 9.

6.5.9 OZONE RESISTANCE—Test procedure and apparatus shall be in accordance with ASTM D 1149, where applicable. For straight hose, 25.40 mm (1 in) ID and under, a specimen of hose of sufficient length shall be bent around a mandrel with OD eight times the nominal OD of the specimen. The two ends shall be tied at their crossing with enameled copper or aluminum wire. After mounting, the specimen shall be allowed to rest in an ozone-free atmosphere for 24 h at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F). The mounted specimen shall be placed in a test chamber with ozone concentration of 100 mPa ± 5 mPa at a temperature of 40 °C ± 2 °C (104 °F ± 3.6 °F). After 70 h of exposure, the specimen shall be removed and allowed to cool to a temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) and then inspected. The specimen shall be visually inspected under 7X magnification and must meet a "0" rating except for the area immediately adjacent to the wire, which shall be ignored. For hoses over 25.40 mm (1 in) ID and preformed parts, prepare a specimen by cutting a strip of whole hose 12.70 mm wide by 100 mm long (1/2 in x 4 in) and tie the specimen (cover out) around a 12.70 mm (1/2 in) diameter mandrel. Condition in the same manner as for whole hose and apply same requirements. This test applies to the cover only and cracks in the exposed tube or cut edges of the cover shall be ignored.

6.5.10 ADHESION TEST—The minimum load required to separate a 25.40 mm (1 in) width of tube and cover shall be 27 N (6 lb).

6.5.11 KINK RESISTANCE—When tested to the following procedure, a ball having a diameter equal to half the nominal inside diameter of the hose shall pass freely through the hose. Use fixture consisting of a 19 mm (0.75 in) thick board or plate with holes and center distances shown in Table 11.

Condition a 300 mm (11.8 in) long specimen of hose for 2 h at room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F). Insert one end of hose into board with end flush with opposite side of the board. Carefully bend hose along its natural curvature and insert the other end carefully into the second hole until it projects 63 mm (2.5 in) out the other side. After hose has been in this position for 5 min, insert a steel ball having a diameter equal to half the hose nominal ID. The ball must pass freely from one end to the other.

6.5.12 RATE OF FUEL PERMEATION—Hoses tested by the reservoir method listed as follows shall meet those limits listed in Table 8 when tested with ASTM Fuel C. Exposure to other fuel blends or various fuels (as in sequential fuel testing) could result in significantly different values. Method is shown in Section 9.

6.5.13 ETHANOL MODIFIED FUEL RESISTANCE—After 70 h immersion at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 using the following test fuel: 85% ASTM Fuel D, 15% anhydrous Denatured Ethanol[4] (denatured with unleaded gasoline per CDA #20), physical values of specimens taken from the tube shall not exceed the changes in values listed in Table 9.

6.5.14 OXIDIZED FUEL TESTING PROCEDURE—Cut three tensile (Die C) specimens for immersion testing per ASTM D 471. No more than three tensile specimens may be immersed per test tube. Each test tube (38 mm diameter by 300 mm long) contains 200 mL of ASTM Fuel "B" to which sufficient tertiarybutyl hydroperoxide has been added to provide a peroxide number, as determined by the method below, of 50. (A well-mixed mixture consisting of 3600 mL of ASTM Fuel "B" and 10 mL of 90% t-butyl hydroperoxide in water will produce a fuel mixture with 50 PN.) All specimen surfaces must be directly exposed to the test liquid. Water-cooled condensers should be attached to the test tubes by non-contaminating means. (Corks, ground glass joints, and foil wrapped rubber stoppers are acceptable.) Place the test tubes in a thermostated environment such that the temperature is maintained at 40 °C ± 2 °C. At 1-, 2-, 3-, and 7-day intervals, replace the test fluid with fresh fuel-hydroperoxide (50 PN) mixture. After 14 days of immersion, cool the samples in ASTM Fuel "B". Determine the reduction in tensile strength and elongation per ASTM D 412. The physical values of specimens from the tube shall not exceed the change in values listed in Table 9.

6.5.14.1 Peroxide Number Analytical Method—The peroxide number here is defined as the number of milliequivalents of peroxide per liter of sample solution.

A sample is refluxed 5 min with sodium iodide and acetic acid in dry isopropanol. The liberated iodine is titrated with standardized thiosulfate to the disappearance of the yellow color. The titrant volume is corrected for any titratable substances in the reagents.

6.5.14.2 Apparatus

a. Flasks, Erlenmeyer, with ground joints, 250 mL capacity
b. Condensers, Allihn or Leibig water-cooled type, 300 mm jacket, with joints to fit above flasks
c. Optional—hot plate or equivalent. Equip with rod and clamps to hold condenser
d. Optional—reagent disperser, 25 mL - Convenient for dispensing the acetic acid in isopropanol reagent
e. 10 mL burette with 0.02 mL graduations
f. Optional—electrometric end point apparatus

6.5.14.3 Reagents

a. Acetic acid, glacial, ACS reagent grade, not over 0.5% water by the Karl Fischer method
b. Sodium iodide, ACS reagent grade, granular
c. Isopropyl alcohol, 99%
d. Sodium thiosulfate solution, 0.1 N accurately standardized
e. Sodium iodide, saturated solution in isopropanol. Reflux 22 g NaI in 100 mL isopropanol for a few minutes, cool to room temperature and filter through rapid filter paper. Store in the dark or in a brown reagent bottle. Replace if the solution gives an appreciable blank when titrated with thiosulfate.
f. Acetic acid in isopropanol. Mix 100 mL of glacial acetic acid and 1150 mL of isopropanol.

6.5.14.4 Procedure

a. Add, from an automatic disperser, 25 mL of the acetic acid in isopropanol solution (Reagent 6) to a 250 mL Erlenmeyer flask.
b. Add 10 mL of the saturated NaI in isopropanol solution (Reagent 5) to the flask.
c. With a pipet, quantitatively transfer a 2 mL portion of sample to the Erlenmeyer flask.
d. Connect the flask to the condenser and heat to a gentle boil, reflux for 5 min. The solution should be dark yellow to brown in color.
e. Raise the flask from the hot plate and support it on an asbestos board to cool, or cool in a water bath.
f. Wash down the condenser with 5 mL of water.
g. Disconnect the flask, and titrate with standardized 0.1 N sodium thiosulfate solution to the disappearance of the yellow color, i.e., from a pale yellow to just colorless. (An electrometric end point apparatus may be used.)
h. Simultaneously run a reagent blank by following the above procedure omitting the sample addition in Step c. The titrant volume of the blank should be in the 0.02 to 0.06 mL range.
i. Calculate the peroxide number according to Equation 1.

6.5.14.5 Calculation

$$(V_s - V_b)N \times 1000/(\text{mL sample}) = \text{Peroxide Number} \qquad \text{(Eq. 1)}$$

where:

V_s = volume of titrant consumed by sample, mL
V_b = volume of titrant consumed by blank, mL
N = normality of standardized sodium thiosulfate solution
1000 = conversion mL to liter

TABLE 11—KINK RESISTANCE

Nominal Hose Inside Diameter mm	Nominal Hose Inside Diameter in	Hose Inside Diameter in	Hole Center Distance mm	Hole Center Distance in	Hole Diameter mm	Hole Diameter in
4.76	3/16	0.188	12.7	0.50	12.7	0.500
6.35	1/4	0.250	19	0.75	14.3	0.562
7.94	5/16	0.312	25.4	1.00	15.9	0.625
9.53	3/8	0.375	76.2	3.00	19	0.750
12.70	1/2	0.500	127.0	5.00	23	0.906

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[4] Available from: Ralph Schrader Company, 3450 Lovett Avenue, Detroit, MI 48210 (or other commercial sources).

6.5.15 STANDARD SODIUM THIOSULFATE SOLUTION, 0.1N—Sodium thiosulfate solutions decompose slowly with deposition of sulfur due to bacterial action unless precautions are taken to inhibit bacterial growth. Use of freshly boiled and cooled water in preparation of $Na_2S_2O_3$ solutions and maintaining the pH on the slightly alkaline side usually gives solutions whose factors will remain constant for two to four weeks. Other precautions that can be taken if bacterial growth persists include sterilization of the containers. Glass can be cleaned thoroughly with dichromate-sulfuric acid cleaning solution and rinsed with sterile water. Polyethylene can be washed thoroughly with chloroform and rinsed with sterile water. A few drops of chloroform added to the prepared solution will also aid in preventing bacteria growth.

6.5.15.1 Reagents

a. Sodium thiosulfate, $Na_2S_2O_3 \cdot 5H_2O$, ACS reagent grade
b. Potassium iodide solution, 10%—dissolve 10 g of ACS reagent grade KI in 100 mL of distilled water
c. Sulfuric acid solution, 40%—add 300 mL of concentrated H_2SO_4 slowly with stirring to 750 mL of distilled water
d. Potassium bromate $KBrO_3$, ACS reagent grade

6.5.15.2 Preparation of 0.1N Solution—Dissolve 25 g of $Na_2S_2O_3 \cdot 5H_2O$ in freshly boiled and cooled distilled water and make up to 1 L.

Titrate a 100 mL portion of the solution with 0.1N NaOH solution using phenolphthalein indicator.

Calculate the volume of alkali required to neutralize the remaining solution as follows:

$$\text{mL NaOH} \times N \times 9 = \text{mL } 0.1\ \underline{N}\ \text{NaOH required} \qquad \text{(Eq. 2)}$$

Add the calculated volume of alkali to the remaining solution, mix thoroughly and withdraw 100 mL. Add two or three drops of phenolphthalein indicator solution. The solution should give a slight pink color.

Store the solution in a brown bottle securely capped. Any precautions to protect the solution from air, e.g., sweeping with nitrogen or other inert gas, should be applied. The solution should be standardized at least monthly.

6.5.15.3 Standardization

6.5.15.3.1 Titration of Potassium Bromate—The reaction is as follows:

$$KBrO_3 + 6KI + 3H_2SO_4 \text{--->} 3I_2 + KBr + 3H_2O + 3K_2SO_4$$
$$2Na_2S_2O_3 + I_2 \text{--->} Na_2S_4O_6 + 2NaI$$

Grind a small amount of $KBrO_3$ to a fine powder and dry for 1 h at 180 °C. Weigh to the nearest 0.1 mg 0.015 to 0.25 g of the dried $KBrO_3$ into a 250 mL Erlenmeyer flask. Add 25 mL of distilled water and swirl to dissolve.

Add 2 mL of 10% KI solution and 1 mL of 40% H_2SO_4 solution. Swirl to mix and allow to stand for 2 or 3 min.

Titrate with the $Na_2S_2O_3$ solution, swirling continuously, until the brown color has changed to a pale yellow. Add titrant slowly, dropwise until the yellow color has disappeared and the solution is colorless.

6.5.15.4 Calculation

$$\text{Grams of } KBrO_3 \times 17.97/(\text{mL of } Na_2S_2O_3) = \underline{N} \text{ of } Na_2S_2O_3 \text{ solution} \qquad \text{(Eq. 3)}$$

Duplicate determination should agree within 0.0003. Report the average of the values found, to the nearest 0.0002, as the normality of the solution.

A number of replicates is advised until the end point change is identified and suitable precision is established.

6.6 Marking—The outer cover will be printed with the designation SAE 30R6, or SAE 30R7, or SAE 30R8 and any other identification as agreed upon between user and manufacturer, repeated every 300 mm (11.8 in).

7. *Fuel Injection Hose Medium-Pressure Coupled and Uncoupled Synthetic Rubber Tube and Cover (SAE 30R9)*—This section covers hose primarily intended to meet the demands of fuel injection systems. These would include, for example, electronic fuel metering (EFM), electronic fuel injection (EFI), throttle body injection (TBI), and the like. Other areas of utility are those applications requiring fuel permeation resistance exceeding 30R8 and ones which require fuel resistance greater than that obtainable with 30R6, 7, and 8. Exposure of this hose to gasoline or diesel fuel that contains high levels, greater than 5% by volume, of oxygenates, i.e., ethanol, methanol, or MTBE may result in significantly higher permeation rates than realized with ASTM Fuel C. This hose may be supplied in either a coupled or uncoupled form, and is useful in the transportation of gasoline, ethanol extended gasoline, diesel fuel, lubrication oil, or the vapor present in either the fuel system or the crankcase of internal combustion engines in mobile, stationary, and marine applications. This hose has a maximum working pressure of 0.69 MPa (100 psi) up to and including 12.70 mm (1/2 in) ID. This hose may be furnished in long lengths, specific cut lengths, or as a part preformed to a specific configuration. This hose is suitable for use in normal operating temperatures of –34 to 135 °C (–29 to 275 °F) and intermittent use at 150 °C (302 °F).

7.1 Hose Construction—The construction of this hose typically consists of a smooth bore tube or laminated tube[5] of a synthetic rubber compound(s) resistant to chemical attack, swelling, and permeation by gasoline, oxidized ("sour") gasoline, ethanol extended gasoline, diesel fuel, and oil or lubricants. It shall be suitably reinforced with a textile fiber, yarn, cord, or fabric, and a cover of a suitable oil-, ozone-, and heat-resistant elastomer.

7.2 Dimensions and tolerances are shown in Table 12.

7.2.1 When hose is supplied in specific cut or long lengths, the length tolerances shall be as in Table 13.

7.2.1.1 End squareness shall be measured as the angle between a plane intersecting the long and short extremes of the hose end and a plane perpendicular to the hose axis. The allowable maximum out-of-square is specified in Table 14.

TABLE 12—DIMENSIONS AND TOLERANCES FOR SAE 30R9

Nominal Size mm	Nominal Size in	Inside Diameter mm	Inside Diameter in	Outside Diameter[1] mm	Outside Diameter[1] in
6.35	1/4	6.35 ± 0.40	0.250 ± 0.016	12.70 ± 0.58	0.500 ± 0.023
7.14	9/32	7.14 ± 0.40	0.281 ± 0.016	13.49 ± 0.58	0.531 ± 0.023
7.94	5/16	7.94 ± 0.40	0.312 ± 0.016	14.29 ± 0.58	0.562 ± 0.023
8.73	11/32	8.73 ± 0.40	0.344 ± 0.016	15.08 ± 0.58	0.594 ± 0.023
9.53	3/8	9.53 ± 0.40	0.375 ± 0.016	15.88 ± 0.58	0.625 ± 0.023
11.11	7/16	11.11 ± 0.58	0.438 ± 0.023	18.26 ± 0.79	0.719 ± 0.031
12.70	1/2	12.70	0.500 ± 0.023	19.84 ± 0.79	0.781 ± 0.031

1. Concentricity, based on total range of indicator readings between the inside bore of the hose and the outer surface of the hose shall not exceed the following values:
Sizes 1/4 in up to 1/2 in: 1.016 mm (0.040 in).

TABLE 13—CUT OR LONG LENGTH TOLERANCES FOR SAE 30R9

Length m	Length in	Precision mm	Precision in	Commercial mm	Commercial in
0–0.3	0–12	± 3.0	±0.12	+9.5 –3.0	+0.38 –0.12
Over 0.31-0.6	Over 12–24	± 4.8	±0.19	+9.5 –4.8	+0.38 –0.19
Over 0.61–0.9	Over 25–36	± 6.3	±0.25	+12.7 –6.3	+0.50 –0.25
Over 0.91–1.2	Over 36–48	± 9.5	±0.38	+12.7 –9.5	+0.50 –0.38
Over 1.21–1.8	Over 48–72	±12.7	±0.50	+19.0 –12.7	+0.75 –0.50

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[5] Laminated tube consists of a thin wall inner tube bonded to an outer tube of a dissimilar material.

TABLE 13—CUT OR LONG LENGTH TOLERANCES FOR SAE 30R9

Length m	Length in	Precision mm	Precision in	Commercial mm	Commercial in
Over 1.81	Over 72		±1%		+2%

TABLE 14—END SQUARENESS

mm	in	Maximum End Out-of-Squareness Angle, Degrees[1]
6.35	1/4	14.2
7.14	9/32	14.1
7.94	5/16	14.0
8.73	11/32	14.0
9.53	3/8	13.9
11.11	7/16	13.7
12.70	1/2	13.5

1. These values were determined by the equation: A = 15 degrees – K x D where:
   A = Maximum Out-of-Squareness Angle
   K = 0.12 degree per mm of Diameter (A slope factor derived from a linear best-fit line using previous squareness requirements.)
   D = Nominal Inside Diameter in mm

7.2.2 When hose is supplied as a preformed item, the tolerances shall be as follows:

7.2.2.1 Arm Lengths—Measured from end to intersection of nearest centerline. Each end shall be as described in 7.2.1. These tolerances apply also to the length of an expanded end.

7.2.2.2 General Layout—Dimensions locating bend intersections are to establish the theoretical centerline of the hose. Actual outside contour of the hose must be held within 4.8 mm (+0.19 in) in all planes with respect to the theoretical outside contour. To check contour, hose ends should first be placed in nominal position (hose may have to be flexed to correct any distortion caused by handling after vulcanization in the producing plant or in shipment) in a checking fixture made in accordance with user requirements from which contour deviation can be measured. Allowance shall be provided in the end mounting area of the fixture for the arm length tolerances which are applicable.

When the ID of an end of the hose is enlarged, the wall gauge of the enlarged end normally changes. Allowable change should be +0.8, –0.5 mm (+0.03, –0.02 in).

7.3 Tests—Procedures described by ASTM D 380 are to be followed wherever applicable.

7.3.1 QUALIFICATION TESTS—For the qualification tests, one 7.5 m (24.6 ft) length of bulk hose, 10 preformed parts, or 10 assemblies of each size to be qualified shall be furnished. In order to qualify under this specification, hose and hose assemblies must meet all the test requirements of 7.4. ASTM test slabs are permissible for testing tube or cover when thickness does not meet ASTM D 412 minimum 1.5 mm (0.060 in).

7.3.2 FREQUENCY OF TESTING FOR INSPECTION—As agreed upon between supplier and user.

7.3.3 INSPECTION TEST—On hose and/or hose assemblies, the following inspection tests shall apply: (7.4.1) burst, (7.4.2) vacuum collapse, (7.4.3) cold flexibility, (7.4.10) adhesion, and (7.4.11) kink resistance, if specified. The kink resistance test shall not normally be required on preformed hose, but may be specified for straight sections of at least 300 mm (11.8 in) length.

7.4 Test Requirements

7.4.1 BURST TEST—The minimum burst for hose sizes through 9.53 mm (3/8 in) ID shall be 6.2 MPa (900 psi). The minimum burst for hose sizes greater than 9.53 mm (3/8 in) ID shall be 3.4 MPa (500 psi). These hoses would have a maximum working pressure of 0.69 MPa (100 psi).

7.4.2 VACUUM COLLAPSE TEST—Test samples shall be subjected to 81 kPa (24 in Hg) vacuum. During the vacuum test described, a 1 m (3.28 ft) length of hose or a hose assembly shall be held in a straight line, and no diameter shall decrease by more than 20% during application of vacuum for a minimum of 15 s and not more than 60 s. The vacuum collapse test on preformed parts should be performed on the finished part.

7.4.3 COLD FLEXIBILITY—For straight hose, the whole hose shall be used for this test. Two samples shall be used. One sample to be dry heat aged for 70 h at the temperature shown in Table 9 and the other completely immersed in ASTM Oil No. 3 for 70 h at the temperature shown in Table 9. After aging, the samples should be conditioned at –34 °C ± 2 °C (–29.2 °F ± 3.6 °F) for 5 h and then flexed in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. The flexing shall take place within 4 s and the hose must not fracture or show any cracks, checks, or breaks in the tube or cover. Proof pressure of 0.69 MPa (100 psi) may be applied to determine tube damage.

7.4.4 TENSILE STRENGTH AND ELONGATION

a. Original tensile strength of cover: 8 MPa (1160 psi) min
b. Original tensile strength of tube or laminated tube: 5 MPa (725 psi) min
c. Original elongation of cover: 150% min
d. Original elongation of tube or laminated tube: 125% min

NOTE—Laminated tube shall be prepared by buffing the "reinforcement side" of slit specimen to the proper test thickness.

7.4.5 DRY HEAT RESISTANCE—The hose shall show no cracks, charring, or disintegration externally or internally when slowly straightened (taking 4 to 8 s) after being exposed as shown in Figure 2 for a period of 7 days at the required temperature shown in Table 9.

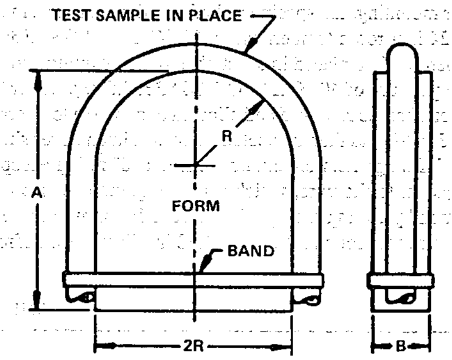

FIGURE 2—TEST SAMPLE ON FORM FOR HEAT AGING TEST (SEE TABLE 15)

7.4.6 FUEL RESISTANCE—After 48 h immersion at room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 in ASTM Reference Fuel C, physical values of specimens taken from the tube or from the inner tube when taken from a laminated tube shall not exceed the change in value as listed in Table 9.

NOTE—If a laminated tube is used, the inner tube must be separated and tested alone. If a satisfactory test specimen cannot be provided from inner tube, than a lab prepared test slab is acceptable.

7.4.7 OIL RESISTANCE—After 70 h immersion at 150 °C ± 2 °C (302 °F ± 3.6 °F) in ASTM Oil No. 3 per ASTM D 471, physical values of specimens taken from the cover shall not exceed the change in value as listed in Table 9.

7.4.8 TEST FOR EXTRACTABLES IN HOSE

7.4.8.1 Apparatus and Reagents

7.4.8.1.1 ASTM Reference Fuel C (50 Toluene - 50 isooctane percent by volume)

7.4.8.1.2 Methanol, 99% minimum purity

7.4.8.1.3 Gooch crucible

7.4.8.1.4 Glass fiber filter, Grade 934AH

7.4.8.1.5 Beaker - 100 mL

7.4.8.1.6 Heating unit

7.4.8.2 Specimens—Hose under test shall be 300 mm (11.8 in) long; plugged at both ends with metal (aluminum or steel) plugs to retain the fluid. Calculate inside surface area based on the actual inside diameter of the hose for its total effective length.

NOTE—Total effective length of hose with end plugs inserted shall be 274 mm (10.8 in).

7.4.8.3 Procedure

7.4.8.3.1 Record hose actual inside diameter, length, and inside surface area. Preferred method is with plug gauges to nearest 0.025 mm (0.001 in).

7.4.8.3.2 Fill hose with ASTM Reference Fuel C.

7.4.8.3.3 Allow to stand for 24 h at temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) with both ends sealed.

NOTE—Solubility of waxy hydrocarbons is affected by temperature.

7.4.8.3.4 Drain fluid from hose into a tared beaker.

7.4.8.3.5 Rinse inside of the specimen with an amount of fresh ASTM Reference Fuel C approximately equal to the volume of the original filling, and add to the original extraction.

7.4.8.3.6 Remove solvent by evaporation by heating at 80 °C (176 °F) to 95 °C (203 °F) until no fuel odor is detectable and then store sample at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) under a fume hood for a minimum of 16 h.

7.4.8.3.7 Take up residue with 30 mL of room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F), methanol.

7.4.8.3.8 Filter this solution on the tared crucible, rinsing beaker twice with 10 mL of room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F), methanol.

7.4.8.3.9 Place crucible in beaker and dry in a 65 to 90 °C (149 to 194 °F) oven for 1 h to insure complete evaporation of methanol.

7.4.8.3.10 Weigh the gooch crucible and tared beaker and determine mass of extractables expressed as g/m^2 using inside surface of hose in contact with ASTM Reference Fuel C.

7.4.8.4 Value for total waxy extractables shall be less than the value in Table 9.

7.4.9 OZONE RESISTANCE—Test procedure and apparatus shall be in accordance with ASTM D 1149, where applicable. For straight hose, sufficient length shall be bent around a mandrel with OD eight times the nominal OD of the specimen. The two ends shall be tied at their crossing with enameled copper or aluminum wire. After mounting, the specimen shall be allowed to rest in an ozone-free atmosphere for 24 h at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F). The mounted specimen shall be placed in a test chamber containing ozone at 100 mPa ± 5 mPa at a temperature of 40 °C ± 2 °C (104 °F ± 3.6 °F). After 70 h of exposure, the specimen shall be removed and allowed to cool to a temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) and then inspected. The specimen cover shall be visually inspected under 7X magnification and must meet a "0" rating except for the area immediately adjacent to the wire, which shall be ignored. For preformed parts, prepare a specimen by cutting a strip of hose 12 x 100 mm long (1/2 x 4 in) and tie specimen (cover out) around a 12.0 mm (1/2 in) diameter mandrel. Condition in the same manner as for whole hose and apply same requirements. This test applies to the cover only and cracks in the exposed tube or cut edges of the cover shall be ignored.

7.4.10 ADHESION TEST—The minimum load (force) required to separate a 25.4 mm (1 in) width of tube and cover per ASTM D 413 (strip method) shall be 35.6 N (8 lb). If a laminated tube is used, the adhesion of the inner tube to outer tube shall be a minimum of 35.6 N (8 lb) or be inseparable to the extent that tearing occurs.

7.4.11 KINK RESISTANCE—When tested to the following procedure, a ball having a diameter equal to one-half the nominal inside diameter of the hose shall pass freely through the hose. Use fixture consisting of a 19 mm (0.75 in) thick board or plate with holes and center distances shown in Table 16.

Condition 300 mm (11.8 in) long specimens of hose for 2 h at room temperature 23 °C ± 2 °C (73 °F ± 3.6 °F). Insert one end of hose into board with end flush with opposite side of the board. Carefully bend hose along its natural curvature and insert the other end carefully into the second hole until it projects 63 mm (2.5 in) out the other side. After hose has been in this position for 5 min, insert a steel ball having a diameter equal to one-half the hose nominal ID. The ball must pass freely from one end to the other.

7.4.12 RATE OF FUEL PERMEATION—Maximum value for fuel permeation shall not exceed limits listed in Table 9 when tested with ASTM Fuel C. If tested with other fuel blends or if exposed to various fuel blends, sequentially, significantly different test results may result. Test method shown in Section 9.

7.4.13 ETHANOL MODIFIED FUEL RESISTANCE—After 70 h immersion at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 using the following test fuel: 85% ASTM Fuel D, 15% anhydrous Denatured Ethanol[6] (denatured with unleaded gasoline per CDA #20), physical values of specimens taken from lab prepared ASTM test slabs of the tube compound, or inner tube if a laminated tube is used, shall not exceed the change in values listed in Table 9.

7.4.14 OXIDIZED FUEL TEST PROCEDURE—See 6.5.14.

7.4.14.1 Tensile Strength and Elongation—The change in physical values should not exceed the values shown in Table 9.

7.5 **Marking**—The outer cover will be printed with the designation SAE 30R9 and any other identification as agreed upon between user and manufacturer, repeated every 300 mm (11.8 in).

8. ***In-Tank, Low-Pressure, Uncoupled Fuel Hoses (SAE 30R10)***—This section covers hose intended primarily for use in fuel injection systems where the hose may be submerged in the fuel tank. The hose is capable of handling gasoline, alcohol-extended gasoline or diesel fuel used in mobile, stationary, and marine applications. This hose has a maximum working pressure of 0.69 MPa (100 psi) up to and including 12.7 mm (1/2 in) ID. This hose may be furnished in long lengths, specific cut lengths, or as a part preformed to a specific configuration. This hose is suitable for use in normal operating temperatures of –34 to 100 °C (–29 to 212 °F) and intermittent use at 125 °C (257 °F).

TABLE 15—DIMENSIONS FOR HEATING TEST FORM

Nominal Inside Diameter mm	Nominal Inside Diameter in	Dimensions of Heat Aging Test Form A mm	Dimensions of Heat Aging Test Form R mm	Dimensions of Heat Aging Test Form B min mm
6.35	1/4	115	40	15
7.14	9/32	120	45	20
7.94	5/16	120	45	20
8.73	11/32	120	45	20
9.53	3/8	130	50	20
11.11	7/16	130	50	20
12.70	1/2	130	50	20

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[6] Available from: Ralph Schrader Company, 3450 Lovett Avenue, Detroit, MI 48210 (or other commercial sources).

TABLE 16—KINK RESISTANCE

Nominal Hose Inside Diameter mm	Nominal Hose Inside Diameter in	Hose Inside Diameter in	Hole Center Distance mm	Hole Center Distance in	Hole Diameter mm	Hole Diameter in
6.3	1/4	0.250	19.0	0.75	14.3	0.562
7.9	5/16	0.312	25.4	1.00	15.9	0.625
9.5	3/8	0.375	76.2	3.00	19.0	0.750
12.7	1/2	0.500	127.0	5.00	23.0	0.906

TABLE 17—LENGTH TOLERANCES FOR IN-TANK, LOW PRESSURE, UNCOUPLED SYNTHETIC RUBBER

Length m	Length in	Precision mm	Precision in	Commercial mm	Commercial in
0–0.3	0–12	±3.0	±0.12	+9.5 –3.0	+0.38 –0.12
Over 0.31–0.6	Over 12–24	±4.8	±0.19	+9.5 –4.8	+0.38 –0.19

8.1 Hose Construction—The construction of this hose consists of a smooth bore tube and cover based on synthetic rubber compound(s) which are resistant to chemical attack or swelling by gasoline, oxidized ("sour") gasoline, alcohol extended gasoline, and diesel fuel. The hose shall be suitably reinforced with a textile fiber, yarn, cord, or fabric which is resistant to the same fuels as the tube and cover.

8.2 Dimensions—Dimensions and tolerances for inside and outside diameters are shown in Table 12.

8.2.1 When hose is supplied in specific cut lengths, the length tolerances shall be as in Table 18.

8.2.1.1 End squareness shall be measured as the angle between a plane intersecting the long and short extremes of the hose end and a plane perpendicular to the hose axis. The allowable maximum out-of-square is specified in Table 14.

8.3 When hose is supplied as a preformed item, the tolerances shall be as follows:

8.3.1 Arm Lengths—Measured from end to intersection of nearest centerline. Each end shall be as described in 8.2.1. These tolerances apply also to the length of an expanded end.

8.3.2 General Layout—Dimensions locating bend intersections are to establish the theoretical centerline of the hose. Actual outside contour of the hose must be held within 4.8 mm (+0.19 in) in all planes with respect to the theoretical outside contour. To check contour, hose ends should first be placed in nominal position (hose may have to be flexed to correct any distortion caused by handling after vulcanization in the producing plant or in shipment) in a checking fixture made in accordance with user requirements from which contour deviation can be measured. Allowance shall be provided in the end mounting area of the fixture for the arm length tolerances which are applicable.

When the ID of an end of the hose is enlarged, the wall gauge of the enlarged end normally changes. Allowable change should be +0.8, –0.5 mm (+0.03, –0.02 in).

8.4 Tests—Procedures described by ASTM D 380, Methods of Testing Rubber Hose, are to be followed wherever applicable.

8.4.1 Qualification Tests—For the qualification tests, one 7.5 m (24.6 ft) length of bulk hose, 10 preformed parts, or 10 assemblies of each size to be qualified shall be furnished. To qualify under this specification, hose and hose assemblies must meet all the test requirements of 8.5. ASTM test slabs are permissible for testing tube or cover when thickness does not meet ASTM D 412 minimum 1.5 mm (0.060 in).

8.4.2 Frequency Of Testing For Inspection—As agreed upon between supplier and user.

8.4.3 Inspection Test—On hose and/or hose assemblies, the following inspection tests shall apply: (8.5.1) burst, (8.5.2) cold flexibility, (8.5.8) adhesion, (8.5.9) kink resistance, if specified. The kink resistance test shall not normally be required on preformed hose, but may be specified for straight sections of at least 300 mm (11.8 in) length.

8.5 Test Requirements

8.5.1 Burst Test—The minimum burst for hose sizes through 9.53 mm (3/8 in) ID shall be 3.4 MPa (500 psi). The minimum burst for hose sizes greater than 9.53 mm (3/8 in) ID shall be 2.8 MPa (400 psi). These hoses would have a maximum working pressure of 0.69 MPa (100 psi).

8.5.2 Cold Flexibility—For straight hose, the whole hose shall be used for this test. Two samples shall be used. One sample to be dry heat aged for 70 h at the temperature shown in Table 9 and the other completely immersed in Fuel C for 70 h at 23 °C ± 2 °C (73 °F ± 3.6 °F). Following immersion in Fuel C, dry out samples for 24 h at 23 °C (73 °F). After aging, the samples should be conditioned at –34 °C ± 2 °C (–29.2 °F ± 3.6 °F) for 5 h and then flexed in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. The flexing shall take place within 4 s and the hose must not fracture or show any cracks, checks, or breaks in the tube or cover. Proof pressure of 0.69 MPa (100 psi) may be applied to determine tube damage.

8.5.3 Tensile Strength And Elongation

8.5.3.1 Original Tensile Strength of Tube and Cover—7 MPa (1015 psi) min.

8.5.3.2 Original Elongation of Tube and Cover—200% min.

8.5.4 Dry Heat Resistance

8.5.4.1 The hose shall show no cracks, charring or disintegration externally or internally when slowly straightened (taking 4 to 8 s) after being exposed, as shown in Figure 5, for a period of 7 days at the temperature shown in Table 9.

8.5.4.2 Age samples of hose for 48 h at room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 in ASTM Reference Fuel C, remove from fluid, dry, then age in dry heat per 8.5.4.1 for 70 h at the temperature shown in Table 9. After aging, hose shall show no cracks, charring, or disintegration externally or internally when slowly straightened (taking 4 to 8 s).

8.5.5 Fuel Resistance

8.5.5.1 After 48 h immersion at room temperature, 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 in ASTM Reference Fuel C, physical values of specimens taken from the tube and cover shall not exceed the change in value as listed in Table 9.

8.5.5.2 Samples of finished hose shall be immersed in ASTM Reference Fuel C for 48 h at 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471. After aging, the hose shall pass the burst test per 8.5.1.

8.5.6 Test For Extractables In Hose

8.5.6.1 Apparatus and Reagents

8.5.6.1.1 ASTM Reference Fuel C (50 Toluene - 50 isooctane percent by volume)

8.5.6.1.2 Methanol, 99% minimum purity

8.5.6.1.3 Gooch crucible

8.5.6.1.4 Glass fiber filter, Grade 934AH

8.5.6.1.5 Beaker - 100 mL

8.5.6.1.6 Heating unit

8.5.6.2 Specimens—Hose under test shall be 300 mm (11.8 in) long; plugged at both ends with metal (aluminum or steel) plugs to retain the fluid. Calculate inside surface area based on the actual inside diameter of the hose for its total effective length.

NOTE—Total effective length of hose with end plugs inserted shall be 274 mm (10.8 in).

8.5.6.3 Procedure

8.5.6.3.1 Record hose actual inside diameter, length, and inside surface area. Preferred method is with plug gauges to nearest 0.025 mm (0.001 in).

8.5.6.3.2 Fill hose with ASTM Reference Fuel C.

8.5.6.3.3 Allow to stand for 24 h at temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) with both ends sealed.

NOTE—Solubility of waxy hydrocarbons is affected by temperature.

8.5.6.3.4 Drain fluid from hose into a tared beaker.

8.5.6.3.5 Rinse inside of the specimen with an amount of fresh Reference Fuel C approximately equal to the volume of the original filling, and add to the original extraction.

8.5.6.3.6 Remove solvent by evaporation by heating at 80 °C (176 °F) to 95 °C (203 °F) until no fuel odor is detectable and then store sample at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) under a fume hood for a minimum of 16 h.

8.5.6.3.7 Take up residue with 30 mL of room temperature 23 °C ± 2 °C (73 °F ± 3.6 °F) methanol.

8.5.6.3.8 Filter this solution on the tared crucible, rinsing beaker twice with 10 mL of room temperature 23 °C ± 2 °C (73 °F ± 3.6 °F) methanol.

8.5.6.3.9 Place crucible in beaker and dry in a 65 to 90 °C (149 to 194 °F) oven for 1 h to insure complete evaporation of methanol.

8.5.6.3.10 Weigh the gooch crucible and tared beaker and determine mass of extractables expressed as g/m^2 using inside surface area of hose in contact with Reference Fuel C.

8.5.6.4 Value for total waxy extractables shall be less than the value shown in Table 9.

8.5.7 Ozone Resistance—Not required.

8.5.8 Adhesion Test—The minimum load (force) required to separate a 25.4 mm (1 in) width of tube and cover per ASTM D 413 (strip method) shall be 35.6 N (8 lb).

8.5.9 Kink Resistance—When tested to the following procedure, a ball having a diameter equal to 1/2 the nominal inside diameter of the hose shall pass freely through the hose. Use fixture consisting of a 19 mm (0.75 in) thick board or plate with holes and center distances shown in Table 16.

Condition 300 mm (11.8 in) long specimens of hose for 2 h at room temperature 23 °C ± 2 °C (73 °F ± 3.6 °F). Insert one end of hose into board with end flush with opposite side of the board. Carefully bend hose along its natural curvature and insert the other end carefully into the second hole until it projects 63 mm (2.5 in) out the other side. After hose has been in this position for 5 min, insert a steel ball having a diameter equal to 1/2 the hose nominal ID. The ball must pass freely from one end to the other.

8.5.10 Alcohol Modified Fuel Resistance

8.5.10.1 After 70 h immersion at room temperature of 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471 using the following test fuel: 85% ASTM Fuel D, 15% anhydrous methanol[7], physical values of specimens taken from the tube and cover shall not exceed the change in values listed as shown in Table 9.

8.5.10.2 Samples of finished hose shall be immersed in the methanol fuel described in 8.5.10.1 for 70 h at 23 °C ± 2 °C (73 °F ± 3.6 °F) per ASTM D 471. After aging, the hose shall pass the burst test per 8.5.1.

8.5.11 Oxidized Gasoline (Gasoline Containing Hydroperoxide)—Samples shall be tested according to the procedure described in 6.5.14. After aging, the physical values of the tube and cover shall not exceed the values as shown in Table 9.

8.6 Marking—The outer cover will be printed with the designation SAE 30R10 and any other identification as agreed upon between user and manufacturer, repeated every 300 mm (11.8 in).

9. Unified Method for Fuel Hose Permeation

9.1 Rate of Fuel Permeation—Hoses tested by the reservoir method meet those limits listed in Table 9 when tested with Fuel C. Exposure of these hoses to gasoline or diesel fuel which contain high levels, greater than 5% by volume, of oxygenates, i.e., ethanol, methanol, or MTBE (methyl tertiary butyl ether), may result in significantly higher permeation rates than those listed in Table 9.

9.1.1 Reservoir Units—See Table 18 for size of reservoir. A screw-top can may be modified by the addition of a standard hose nipple, or fitting, cold soldered into the base at the corner opposite its opening. See Figure 3 for typical equipment. Other types of reservoir units may be used. Examples are cylindrical aluminum and steel containers with appropriate standard hose nipples at one end, and a fill opening if required at the other end. The materials used for construction of the reservoirs should be compatible with the test fuel.

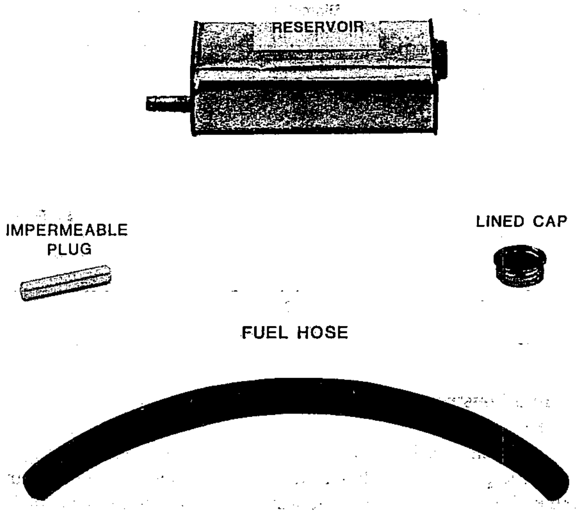

FIGURE 3—FUEL PERMEATION TEST APPARATUS

9.1.2 Screw Cap—A metal foil or fluoroelastomer-lined cap to seal the reservoir unit. Where the threaded fill opening is designed to seal with an O-ring, a fluoroelastomer O-ring shall be used. The threaded fill opening may be either a female or male thread and sealed with a threaded male plug or female cap.

9.1.3 Scale or Balance—A weighing unit with sufficient capacity to weigh the filled assemblies, and with a resolution of ±0.01 g.

9.1.4 Impermeable Plug—An impermeable plug of sufficient size to seal one end of the hose to a depth of 25 mm.

9.1.5 Hose Clamps—Standard hose clamps of the correct size for the hose being tested.

9.2 Procedure

a. Cut hose to the required length (active length plus the fitting lengths). See Table 18.
b. Measure the inside diameter of the hose and record in mm.
c. Plug one end of hose to the required depth using an impermeable plug and hose clamp.
d. Attach the other end of hose to the fitting on the reservoir and clamp.
e. Measure the active or exposed length of the installed hose in mm and record.
f. Fill the reservoir with the specified amount (see Table 18) of desired fuel blend.
g. Seal reservoir with cap or plug.
h. Weigh reservoir assembly to the nearest 0.01 g and record.
i. To insure complete filling of the hose, orient assembly vertically and gently tap hose to eliminate the possibility of trapped air in the hose. See Figure 4.

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[7] Reagent grade.

FIGURE 4—FUEL PERMEATION TEST—AIR BUBBLE REMOVAL POSITION

j. Place assembly with the hose horizontal in its storage position for liquid permeation (Figure 5).

k. Weigh the assembly each 24 h ± 0.5 h for the required time interval and record each value.

l. After each weighing, invert assembly to drain hose, gently mix fuel, and refill hose as in step i and replace in storage position.

m. Calculate the exposed tube area (A) in m^2: $A = L(mm) \times ID(mm) \times 3.14 \times 10^{-6}$.

n. Calculate the rate of fuel permeation in terms of $g/m^2/24$ h of exposed tube area on a daily basis.

10. Low Permeation Fuel Fill, Vent, and Vapor Hose (SAE 30R11)—This section covers the minimum requirements for a low permeation hose (100 g/m^2/day or less) for use as a low pressure (14.5 kPa) liquid or vapor carrying component for use in gasoline or diesel fuel filler, vent, and vapor systems. The construction shall be designed to be functional over a temperature range of –40 °C to 100 °C for T1 designation, or –40 °C to 125 °C for the T2 designation.

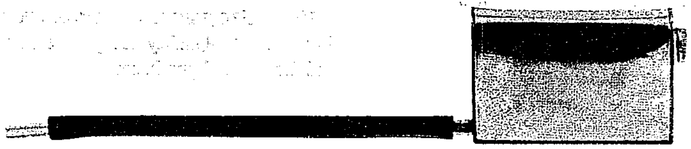

FIGURE 5—FUEL PERMEATION RESERVOIR TEST—ASSEMBLY STORAGE POSITION

10.1 Hose Construction—The construction typically consists of a smooth bore or laminated tube of one or more synthetic rubber compound(s) and/or thermoplastic material(s) resistant to chemical attack, swelling, and permeation by gasoline, alcohol extended gasoline, or diesel fuel. It will be suitably reinforced with a textile fiber, yarn, cord, or fabric. It will also be covered with a suitable oil, ozone, and heat-resistant synthetic rubber compound and/or thermoplastic. The specific construction details are to be agreed between the supplier and the original purchaser.

10.2 Dimensions

10.2.1 The ends of the hose shall be square within 3.0 mm for sizes up to but excluding 25.4 mm ID, 6.4 mm for sizes 25.4 mm through 50.8 mm ID, and 9.5 mm for sizes over 50.8 mm ID. Reference Table 19.

10.2.2 When hose is supplied in specific cut or long lengths, the length tolerances shall be as in Table 20.

TABLE 18—TEST PIECE SIZE PARAMETERS

Inside Diameter of Test Hose mm	Active Length of Test Hose mm	Reservoir Size in mL	Fuel Fill Amount mL
≤ 16.0	300	460 – 490	300
>16.0 to 25.0	300	940 – 1000	750
>25.0 to 32.0	300	3750 – 4000	2500
>32.0	150	3750 – 4000	2500

NOTE 1—Storage location should be temperature controlled to 23 °C ± 2 °C (73 °F ± 3.6 °F) with free-flowing air to prevent fume buildup.

NOTE 2—If weekend weighings are to be eliminated and the results averaged for the weekends, then the test must be started on a Monday.

10.2.3 End squareness shall be measured as the angle between a plane intersecting the long and short extremes of the hose end and a plane perpendicular to the hose axis. The allowable maximum out-of-squareness is specified in Table 19.

10.3 When a hose is supplied as a preformed item, the tolerance shall be as follows:

10.3.1 SQUARENESS OF ENDS—The tolerance on squareness of ends of preformed parts shall be a minimum 15% of the nominal hose OD on all sizes though 25.4 mm ID, 6.3 mm for sizes over 25.4 mm ID through 50.8 mm ID and 9.5 mm for sizes over 50.8 mm ID. End squareness shall be measured as described in 10.2.1.

10.3.2 ARMS LENGTHS—Measured from end to intersection of nearest centerline. Each end shall be as described in 10.2. These tolerances apply also to the length of an expanded end.

10.3.3 GENERAL LAYOUT—Dimensions locating bend intersections are to establish the theoretical centerline of the hose. Actual outside contour of the hose must be held within 4.8 mm in all planes with respect to the theoretical outside contour. To check contour, hose ends should first be placed in nominal position (it may have to be flexed to correct any distortion caused by handling after vulcanization in the producing plant or in shipment) in a checking fixture made in accordance with user requirements from which contour deviation can be measured. Allowance shall be provided in the end mounting area of the fixture for the arm length tolerances which are applicable.

When the ID of an end of the hose is enlarged, the wall gauge of the enlarged end normally changes. Allowable change should be +0.8/–0.5 mm. The wall gauge within bends of a preformed hose may differ from the gauge in straight portions. The difference shall not exceed 33%.

10.4 Tests—Procedures described by ASTM D 380 are to be followed. All temperature tolerances are ±2 °C unless otherwise specified.

10.4.1 QUALIFICATION TESTING—In order to qualify under this specification, hose or the assembly must meet all the applicable test requirements of 10.5. Hose for testing will be 12.7 mm ID or as agreed upon between supplier and user. The construction must be representative of construction of all other sizes. The impermeable layer thickness cannot be reduced with other data.

TABLE 19—DIMENSIONS AND TOLERANCES FOR SAE 30R11

Nominal Size mm	Inside Diameter mm	Outside Diameter(1) mm	End Out-of Squareness Angles, Deg(2)
4.0	4.0 ± 0.4	9.1 ± 0.6	14.5
4.8	4.8 ± 0.4	10.3 ± 0.6	14.4
5.6	5.6 ± 0.4	11.1 ± 0.6	14.3
6.4	6.4 ± 0.4	12.7 ± 0.6	14.2
7.0	7.0 ± 0.4	13.5 ± 0.6	14.1
7.9	7.9 ± 0.4	14.3 ± 0.6	14.0
8.7	8.7 ± 0.4	15.1 ± 0.6	14.0
9.5	9.5 ± 0.4	15.9 ± 0.6	13.9
11.1	11.1 ± 0.6	18.3 ± 0.8	13.7
12.7	12.7 ± 0.6	19.8 ± 0.8	13.5
15.9	15.9 ± 0.8	23.8 ± 0.8	13.1
19.1	19.1 ± 0.8	28.6 ± 0.8	12.7
25.4	25.4 ± 0.8	34.9 ± 1.6	12.0
31.8	31.8 ± 1.0	not specified(3)	11.2
38.1	38.1 ± 1.0	not specified(3)	10.4
44.5	44.5 ± 1.0	not specified(3)	9.7
50.8	50.8 ± 1.0	not specified(3)	8.9
57.2	57.2 ± 1.0	not specified(3)	8.1
63.5	63.5 ± 1.0	not specified(3)	7.4

1. Concentricity based on total indicator reading between the inside bore and the outer surface of the hose or tube shall not exceed the values given as follows:
    - Sizes 6.4 mm and under: 0.762 mm
    - Sizes over 6.4 mm up to 12.7 mm: 1.016 mm
    - Sizes over 12.7 mm: 1.270 mm
2. These values were determined by the equation:

   A = 15 degrees – K X D

   where:

   A = Maximum out-of-squareness angle

   K = 0.12 degree per mm of diameter (a slope factor derived from linear best-fit previous squareness requirement)

   D = Nominal inside diameter in millimeters
3. The wall gauge for sizes 31.8 mm to 50.8 mm shall be between 4.3 to 5.9 mm, and for sizes 57.2 mm to 63.5 mm, between 4.3 to 6.4 mm

TABLE 20—CUT OR LONG LENGTH TOLERANCES FOR SAE 30R11

Length m	Precision mm	Commercial mm
0–0.3	±3.0	+9.5/–3.0
over 0.3–0.6	±4.8	+9.5/–4.8
over 0.6–0.9	±6.3	+12.7/–6.3
over 0.9–1.2	±9.5	+12.7/–9.5
over 1.2–1.8	±12.7	+19.0/–12.7
over 1.8	±1%	+2%/0%

10.4.2 FREQUENCY OF TESTING FOR QUALIFICATION—Qualification testing to be performed once annually except for permeation testing which only needs to be tested intially.

10.4.3 INSPECTION TESTING—On hose or the assembly, the following inspection shall apply: (10.5.1) burst, (10.5.2), vacuum collapse, (10.5.11.1), original adhesion, (10.5.12), kink resistance, and (10.5.6), electrical conductivity (if required).

10.4.4 FREQUENCY OF TESTING FOR INSPECTION AND QUALITY ACCEPTANCE STANDARDS—Quality acceptance standards to be agreed upon between supplier and the original purchaser.

10.5 Test Requirements

10.5.1 Burst Test (Inspection Test on all sizes)—The minimum burst shall be 1.20 MPa per ASTM D 380.

10.5.2 Vacuum Collapse Test (Inspection Test on all sizes)—For straight hose, a 1 m length of hose or the assembly shall be held in a straight line. On preformed parts, the vacuum collapse test shall be performed on the finished part. No diameter shall decrease by more than 20% during application of vacuum for a minimum of 15 s and not more than 60 s. Hose sizes as listed in Table 20 shall be subjected to the corresponding vacuum pressure.

10.5.3 Low Temperature Flexibility (Qualification Test)—Fill hose with Reference Fuel C and seal both ends. Allow it to condition at 23 °C for 168 h. Drain the fuel. Immediately expose the hose along with a mandrel that is 10 times the nominal ID to a temperature of –40 °C for 24 h. Bend the hose or sample around the mandrel while keeping both at the prescribed temperature. It shall not fracture and shall not show cracks, checks, or breaks in any of the layers of construction.

10.5.4 Original Material Properties (Qualification Test)—The test procedure and apparatus shall be accordance with ASTM D 412, where applicable.

a. Original tensile strength of cover: 7 MPa min
b. Original tensile strength of tube or laminated tube: 7 MPa min
c. Original elongation of cover: 150% min
d. Original elongation of tube or laminated tube: 150% min

NOTE—Test sample shall be prepared by buffing or skiving the "reinforcement side" of the specimen to the proper test thickness.

10.5.5 Heat Resistance (Qualification Test)—Expose a 300 mm length hose for 1000 h at the prescribed test temperature. The test temperature for a T1 construction is 100 °C and 125 °C for the T2 construction. Remove the hose from the oven and allow it to cool to room temperature for a minimum of 2 h. Bend it over a mandrel having a diameter of 10 times the nominal OD within 4 s. Examine it, both inside and outside. The hose shall show no cracks or breaks.

10.5.6 Electrical Conductivity (Inspeciton Test on all sizes)—The purpose is to provide a conductive pathway to dissipate any static electrical buildup. **This test is required only for hose that will be designated as electrically conductive.**

An entire hose (maximum length 610 mm) will be used for this test, unless its length exceeds 610 mm, at which time the length for test shall be 610 mm. Insert a brass, steel, or copper plug or fitting into each end. Place clamps on each end of the hose and firmly tighten. Attach the ohmmeter electrodes to the plugs at each end. Measure the resistance between the plugs while applying 550 V DC (±50 V). The maximum resistance allowable is 10 MΩ.

NOTE 1—The diameter of the plug or fitting should be close to the ID of the hose.

NOTE 2—The hose while under test should be placed on a nonconductive surface.

NOTE 3—Ohmmeter must have the capability of measuring resistance from 10^{-1} to 10^{3} MΩ at 550 V DC.

10.5.7 Oil Resistance (Qualification Test)—After immersion in IRM 903 oil for 70 h at 125 °C per ASTM D 471, the volume change of a sample taken from the hose cover shall not exceed +60%.

10.5.8 Fuel Resistance (Qualification Test)—After immersion in ASTM Reference Fuel C for 48 h at 23 °C per ASTM D 471, the physical values of the specimens taken from the tube or inner tube, when taken from a laminated tube, shall not exceed the change in value as follows:

a. Tensile Change:–45% max
b. Elongation Change:–45% max
c. Volume Change:0 to 50%

NOTE—If a laminated tube is used, the inner tube must be separated and tested alone. If a satisfactory test specimen cannot be provided from the inner tube, then a lab prepared test slab is acceptable.

10.5.9 Test for Extractables in Hose (Qualification Test)—Use the procedure described in 6.5.8. Value for total waxy extractables shall be less than 2.50 g/m^2.

10.5.10 Ozone Resistance (Qualification Test)—Use the procedure described in 6.5.9. The specimen cover shall be visually inspected under 7X magnificaiton and must meet a "0" rating except for the area immediately adjacent to the wire, which shall be ignored.

NOTE—This test applies to the cover only and cracks in the exposed tube or cut edges of the cover shall be ignored.

10.5.11 Adhesion

10.5.11.1 Original Adhesion (Inspection Test on All Sizes)—Cut out 25 mm samples out of the hose in the transverse direction. The number of samples to be tested is dependant on the construction of the hose but should be enough to test the adhesion between all adjacent layers. When tested in accordance with ASTM D413, Machine Method, Strip Specimen - Type A, 180° Peel, the minimum force required to separate the two layers shall be 1 N/mm or stock tear.

10.5.11.2 Aged Adhesion (Qualification Test)

a. Sample conditioning:
   1. Use hose or tube from the permeation test (10.5.13)
   2. Alternate method
      Plug one end of the hose or tube to be tested. Fill with test fuel CM15.
      Plug the other end of the hose or tube in such a manner that it can be periodically removed.
      Expose the filled hose to a temperature of 40 °C for 1000 h continuously. Change the fuel every 168 h.

TABLE 21—VACUUM COLLAPSE PRESSURE FOR SAE 30R11

Hose ID Size	Vacuum Pressure
<12.7 mm	81 kPa
12.7 to 25.4 mm	34 kPa
>25.4 to 44.5 mm	14.3 kPa
>44.5 mm	Limit to be agreed upon between supplier and manufacturer

TABLE 22—MARKING FOR SAE 30R11

"X" Designation	Permeation Range	"Y" Designation	Electrical Conductivity	"Z" Designation	Temperature
A	0 to 25	E	Conductive	T1	100 °C
B	25 to 50	N	Non-conductive	T2	125 °C
C	50 to 100				

b. Cut 25 mm samples out of the hose in the transverse direction. The number of samples to be tested is dependant on the construction but should be enough to test the adhesion between all adjacent layers.
c. Condition the test samples in a 70 °C oven for 24 h followed by 2 h at 23 °C.
d. Test for adhesion in accordance with ASTM D 413, Machine Method, Strip Specimen-Type A, 180° Peel, the minimum force required to separate the two layers shall be 1.0 N/mm or stock tear.

10.5.12 Kink Resistance (Inspection Test on All Applicable Sizes)

NOTE—This test is not applicable for hose over 12.7 mm ID nor for formed hose. Use test procedure described in 6.5.11. The ball must pass freely from one end to the other.

10.5.13 Permeation Resistance—(Initial Qualification Test only)

NOTE—After completion of this test, save hose or tube if performing adhesion testing.

a. Test Method—The test procedure and apparatus shall be in accordance with SAE J1737.
b. Test Conditions—CM15 will be used as the fuel source at a temperature of 40 °C and a pressure of 14.5 kPa. The suggested ID is 12.7 mm and the construction shall be representative of planned production hose or tube.
c. Precondition the hose or tube for 664 h at 40 °C, changing the fuel every 168 h followed immediately by permeation testing for a minimum of 336 h at 40 °C.
d. A minimum of 3 specimens must be tested by this procedure. The median of the three measurements shall be used to describe the permeation rate.
e. Units reported from the measurement shall be grams/meter^2/day and shall be reported as a whole number by following all the guidelines of 8.3 of SAE J1737.

10.6 Marking—The outer cover will be printed with the designation SAE 30R11XYTZ along with any other identification agreed upon between user and manufacturer, repeated every 300 mm. The "X" designation (Table 22) shall indicate the range that the permeation rate falls within. The "Y" designation will be either "E" for electrically conductive hose or "N" for non-conductive hose or tube. The "Z" designation will be either 1 for 100 °C heat resistance or 2 for 125 °C heat resistance.

NOTE—Some examples of the markings follow:

SAE 30R11ANT1 This hose is designed to meet the 0 to 25 g/m^2/day permeation range. It will meet the 100 °C heat requirement and is not electrically conductive.

SAE 30R11ANT2 This hose is designed to meet the 0 to 25 g/m^2/day permeation range. It will meet the 125 °C heat requirement and is not electrically conductive.

SAE 30R11AET2 This hose is designed to meet the 0 to 25 g/m^2/day permeation range. It will meet the 125 °C heat requirement and is electrically conductive.

11. Low Permeation Fuel Feed and Return Hose (SAE 30R12)—This section covers the minimum requirements for low permeation reinforced hose suitable for use in fuel supply systems including fuel injection systems. This section applies to hose with an elastomeric inner layer. Hose with a thermoplastic inner layer is specifically excluded.

Low permeation hose, for the purpose of SAE 30R12, is defined as hose having a permeation rate less than 100 g/m^2/day by method SAE J1737 when tested with CM15 fuel at 60 °C.

This hose is intended for use as fuel feed and return hose in applications where low levels of evaporative emissions are required. This hose is useful in this and other applications for the transportation of gasoline, ethanol or methanol extended gasoline, reformulated gasoline (RFG), alcohol fuel, diesel fuel, lubrication oil, or the vapor present in either the fuel system or the crankcase of internal combustion engines in mobile, stationary, and marine applications. This hose has a maximum working pressure of 1.0 MPa (145 psi).

This section covers hose suitable for use in four categories of operating temperature ranges. Category T1 hose is suitable for use in a normal operating temperature range from –40 °C to 100 °C; Category T2 hose is suitable for use in a normal operating temperature range from –40 °C to 125 °C; Category T3 hose is suitable for use in a normal operating temperature range from –40 °C to 135 °C; and Category T4 hose is suitable for use in a normal operating temperature range from –40 °C to 150 °C.

This hose may be furnished in long lengths, specific cut lengths, or as a part preformed to a specific configuration.

11.1 Hose Construction—The construction of this hose typically consists of a smooth bore tube with an internal diameter below 13 mm (0.5 inch) which is resistant to chemical attack, swelling and permeation by gasoline, oxidized ("sour") gasoline, alcohol extended gasoline, reformulated gasoline (RFG), alcohol fuels, diesel fuel and oil or lubricants. The tube may be composed of a single elastomeric material or be a laminated construction of two or more synthetic rubber compounds and/or thermoplastic materials provided the innermost layer is an elastomeric layer. The tube shall be suitably reinforced with a textile fiber, yarn, cord or fabric and covered with an oil, ozone, and heat-resistant elastomer.

11.2 Dimensions and Tolerances

11.2.1 Recommended dimensions and tolerances are the same as those for SAE J30R9 hose shown in Table 12, 7.2. Maximum recommended size for 30R12 hose is 13 mm (0.5 in) ID. However, it is not the intent of this section to exclude hose with different dimensions that comply with all other requirements of this document. Other dimensions and sizes are acceptable if agreed upon between buyer and seller.

11.2.1.1 When hose is supplied in specific cut or long lengths, the length tolerances shall be as in Table 13, 7.2.1.

11.2.1.2 End squareness shall be measured as the angle between a plane intersecting the long and short extremes of the hose end and a plane perpendicular to the hose axis. The allowable maximum out-of-square is specified in Table 14, 7.2.1.1.

11.2.2 When hose is supplied as a preformed item, the tolerances shall be as follows:

11.2.2.1 Arm Lengths Measured from end to intersection of nearest centerline. Each end shall be as described in 7.2.1. These tolerances apply also to the length of an expanded end.

11.2.2.2 General Layout—Dimensions locating bend intersections are to establish the theoretical centerline of the hose. Actual outside contour of the hose must be held within 4.8 mm (+0.9 in) in all planes with respect to the theoretical outside contour. To check contour, hose ends should first be placed in nominal position (hose may have to be flexed to correct any distortion caused by handling after vulcanization in the producing plant or in shipment) in a checking fixture made in accordance with user requirements from which contour deviation can be measured. Allowance shall be provided in the end mounting area of the fixture for the arm length tolerances which are applicable.

When the ID of an end of the hose is enlarged, the wall gauge of the enlarged end normally changes. Allowable change should be +0.8, –0.5 mm (+0.03, –0.02 in).

11.3 Tests—Procedures described by ASTM D 380 are to be followed wherever applicable. ASTM test slabs are permissible for testing tube or cover when thickness does not meet ASTM D 412 minimum 1.5 mm (0.06 in).

11.3.1 Qualification Tests—In order to qualify under this specification, hose and/or hose assemblies must meet all the applicable test requirements of 11.4. Qualification testing is to be performed on samples of the largest ID size to be supplied, or on 13 mm (0.5 in) ID hose, whichever is smaller. The hose used for qualification tests must be representative of the construction of all other sizes. The impermeable layer thickness of the qualification sample cannot be greater than that of the other sizes.

11.3.1.1 Frequency of Testing for Qualification—Qualification testing is to be performed once per year, with the exception of permeation testing (11.4.12) which is to be performed on original qualification only.

11.3.2 Inspection Testing—On hose and/or hose assemblies, the following inspection tests shall apply: (11.4.1) burst, (11.4.2) vacuum collapse, (11.4.10.1) original adhesion, (11.4.11) kink resistance and (11.5.2) electrical conductivity (if specified). The kink resistance test shall not normally be required on preformed hose, but may be specified for straight sections of at least 300 mm (11.8 in) length.

11.3.2.1 Frequency of Testing for Inspection and Quality Acceptance Standards—As agreed upon between supplier and user.

11.3.3 Test Tolerances—Temperatures specified in the test procedures shall be held to ±2 °C and pressures shall be held to –0, +0.35 kPa (5 psi) unless otherwise specified. Room temperature is to be taken as 23 °C ± 2 °C.

11.4 Test Requirements

11.4.1 Burst Pressure (Inspection Test—All Sizes)—The minimum burst pressure shall be 8.0 MPa (1160 psi). These hoses have a maximum working pressure of 1.0 MPa (145 psi).

11.4.2 Vacuum Collapse (Inspection Test—All Sizes)—Test samples shall be subjected to 80 kPa (600 mm of Hg) vacuum. During the vacuum test described, a 1 m (3.3 ft) length of hose or a hose assembly shall be held in a straight line, and no diameter shall decrease by more than 20% during application of vacuum for a minimum of 15 s and not more than 60 s. The vacuum collapse test on preformed parts should be performed on the finished part.

11.4.3 Low Temperature Flexibility (Qualification Test—Annually on Nominal 13 mm Hose)—Fill the hose with Reference Fuel C and seal both ends. Allow the filled hose to condition at 23 °C for 168 h. Drain the fuel from the hose and immediately place the hose in a cold box maintained at –40 °C. Condition the hose for 24 h at –40 °C. After conditioning, flex the hose in the cold chamber through 180 degrees from the centerline to a diameter of 10 times the maximum OD of the hose. The flexing shall take place within 4 s and the hose must not fracture or show any cracks, checks, or breaks in the tube or cover. Proof pressure of 1.0 MPa (145 psi) may be applied to determine tube damage.

11.4.4 Original Material Properties (Qualification Test—Annually Nominal 13 mm Hose or Test Slabs):

a. Original tensile strength of cover:	7 MPa (1015 psi) min
b. Original tensile strength of tube or laminated tube:	7 MPa (1015 psi) min
c. Original elongation of cover:	150% min
d. Original elongation of tube or laminated tube:	150% min

NOTE—Laminated tube shall be prepared by buffing or slitting the "reinforcement side" of slit specimen to obtain the proper test thickness.

11.4.5 Dry Heat Resistance (Qualification Test—Annually on Nominal 13 mm Hose)—The hose shall show no cracks, charring, or disintegration externally or internally when slowly straightened (taking 4 to 8 s) after being exposed as shown in Figure 2, 7.4.5 for a period of 1000 h at the upper use temperature for the appropriate temperature category (100 °C for Category T1, 125 °C for Category T2, 135 °C for Category T3, or 150 °C for Category T4).

11.4.6 Fuel Resistance (Qualification Test—Annually on Nominal 13 mm Hose or Test Slabs)—After 168 h immersion at 23 °C per ASTM D 471 in the test fuel, samples of the fuel contact layer cut from the tube or lab prepared samples of fuel contact layer material shall meet the requirements shown as follows:

a. Test Fuel:	CM15	CM85
b. Max volume change:	+25%	+25%
c. Max change in Tensile Strength:	–40%	–40%

11.4.6.1 Oxidized Fuel Resistance (Qualification Test—annually on nominal 13mm hose or test slabs)—Repeat the testing of 11.4.6 using auto-oxidized test fuel prepared according to SAE J1681, 3.2.2.3. After 168 h immersion at 23 °C per ASTM D 471 in the auto-oxidized test fuel, samples of the fuel contact layer cut from the tube or lab prepared samples of fuel contact layer material shall meet the requirements shown as follows:

a. Auto-Oxidized Test Fuel:	CM15[8]	CM85[8]
b. Max volume change	+25%	+25%
c. Max change in Tensile Strength	–40%	–40%

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[8] Test fuel with 50 milli-mole of t-Butyl Hydroperoxide and 0.01 mg Cu per liter of fuel prepared according to SAE J681, 3.2.2.3.

11.4.7 OIL RESISTANCE (QUALIFICATION TEST—ANNUALLY ON NOMINAL 13 mm HOSE)—After immersion in IRM 903 oil for 70 h at the upper use temperature for the appropriate temperature category (100 °C for Category T1, 125 °C for Category T2, 135 °C for Category T3, or 150 °C for Category T4) per ASTM D 471, the volume change of a sample taken from the hose cover shall not exceed +60%.

11.4.8 EXTRACTABLES (QUALIFICATION TEST—ANNUALLY ON NOMINAL 13 mm HOSE)—The value for total waxy extractables shall not exceed 2.50 g/m^2 when the hose is tested by the method in 7.4.8.

11.4.9 OZONE RESISTANCE (QUALIFICATION TEST—ANNUALLY ON NOMINAL 13 mm HOSE)—The hose cover shall meet a "0" rating after the hose has been exposed to ozone at 100 mPa at 40 °C per the procedure in 6.5.9.

11.4.10 ADHESION

11.4.10.1 Original Adhesion (Inspection Test—All Sizes)—Cut 25 mm samples out of the hose in the transverse direction. The number of samples to be tested is dependent on the construction of the hose but should be enough to test the adhesion between all adjacent layers. When tested in accordance with ASTM D413, Machine Method, Strip Specimen - Type A, 180° Peel, the minimum force required to separate the cover from the tube, and to separate adjacent layers of a multilayer tube shall be 1.4 N/mm of width or the bond shall be inseparable to the extent that tearing of the materials occurs.

11.4.10.2 Fuel Aged Adhesion (Qualification Test—Annually on Nominal 13 mm Hose)—Condition the hose by filling with CM15 Fuel and se[illegible] ends. Allow the filled hose to condition at 40 °C for a total of 1000 h. Drain and fill with fresh CM15 fuel every week. (As an option, hose that has undergone permeation testing per 11.4.12 may be used for this test.) Cut 25 mm samples out of the hose in the transverse direction. The number of samples to be tested is dependent on the construction of the hose but should be enough to test the adhesion between all adjacent layers. Condition the cut test specimens in a 70 °C oven for 24 h followed by 2 h at room temperature. When tested in accordance with ASTM D 413, Machine Method, Strip Specimen - Type A, 180° Peel, the minimum force required to separate the cover from the tube, and to separate adjacent layers of a multilayer tube shall be 1.0 N/mm of width or the bond shall be inseparable to the extent that tearing of the materials occurs.

11.4.11 KINK RESISTANCE (INSPECTION TEST—ALL SIZES)—When tested to the procedure in 7.4.11, a ball having a diameter equal to one-half the nominal inside diameter of the hose shall pass freely through the hose.

11.4.12 PERMEATION (QUALIFICATION TEST—INITIAL QUALIFICATION ON NOMINAL 13 mm HOSE)—Precondition the hose by filling with CM15 fuel and sealing both ends. Allow the filled hose to condition at 60 °C for a minimum of 664 h or at 40 °C for a minimum of 1000 h. Drain and refill with fresh CM15 fuel every week during the conditioning period.

Permeation test procedure and apparatus shall be in accordance with SAE J1737. Permeation testing shall be performed for 336 h on a minimum of three preconditioned hoses using CM15 fuel at a temperature of 60 °C and a pressure of 0.2 MPa.

Calculate daily permeation rates (exclusive of weekends) for the test period (weight gain of carbon canister from one weighing to the next divided by the time in hours between weighings). At the end of the testing period, calculate the time average permeation for the last 10 days (total weight gain of the carbon canister for the last 10-day period divided by the corresponding time in hours). Calculate permeation in units of g/m^2/day using the permeation rate above and the inside surface area of the hose sample in square meters. Report the median value of the permeation rate of the test samples as a whole number and use this number to determine which of the following low permeation categories the hose complies with:

a. Category A 0 to 25 g/m^2/day
b. Category B 26 to 50 g/m^2/day
c. Category C 51 to 100 g/m^2/day

11.4.13 ELECTRICAL CONDUCTIVITY (INSPECTION TEST—ALL SIZES, IF APPLICABLE)—An entire hose (maximum length 610 mm) shall be tested to the following requirements:

Insert a conductive plug or fitting (brass, steel, or copper) into each end of hose. Clamp with a (12.7 mm) band clamp on each end tightening clamps firmly. After clamping allow the hose to rest for 10 min before testing. Attach the ohmmeter electrodes to the plugs (or fittings) at each end and measure the resistance between the plugs or fittings over the entire length or the part, with the part laid on a non-conductive surface. Voltage applied for the measurement shall be 550 V DC ± 50 V DC. Resistance is to be recorded in megaohms.

The resistivity measured for the hose test sample must be less than or equal to 10 MΩ in order for the hose to be marked "E" (see 11.5).

11.5 Marking—The outer cover will be printed with the designation SAE30R12xyTz along with any other identification agreed upon between user and manufacturer, repeated every 300 mm.

a. The "x" designation shall indicate the range that the permeation rate falls within.

"x" Designation
A 0 to 25 g/m^2/day
B 26 to 50 g/m^2/day
C 51 to 100 g/m^2/day

b. The "y" designation is to be used to show if the hose meets the conductivity requirements of 11.4.13.

"y" Designation
N Non-conductive (no conductivity Requirement)
E Conductivity less than 10 MΩ

c. The "T" designation indicates that the hose meets the upper use temperature category given by "z" and meets the requirements of 11.4.3.2, 11.4.5, and 11.4.7 when tested at the corresponding "z" temperature.

"Tz" Designation

	Upper Use Temperature
T1	100 °C
T2	125 °C
T3	135 °C
T4	150 °C

For example; a non-conductive hose with a permeation rate of 15 g/m^2/day and an upper use temperature of 135 °C would be marked:

SAE 30R12ANT3

and a conductive hose with a permeation rate of 40 g/m^2/day and an upper use temperature of 125 °C would be marked:

SAE 30R12BET2